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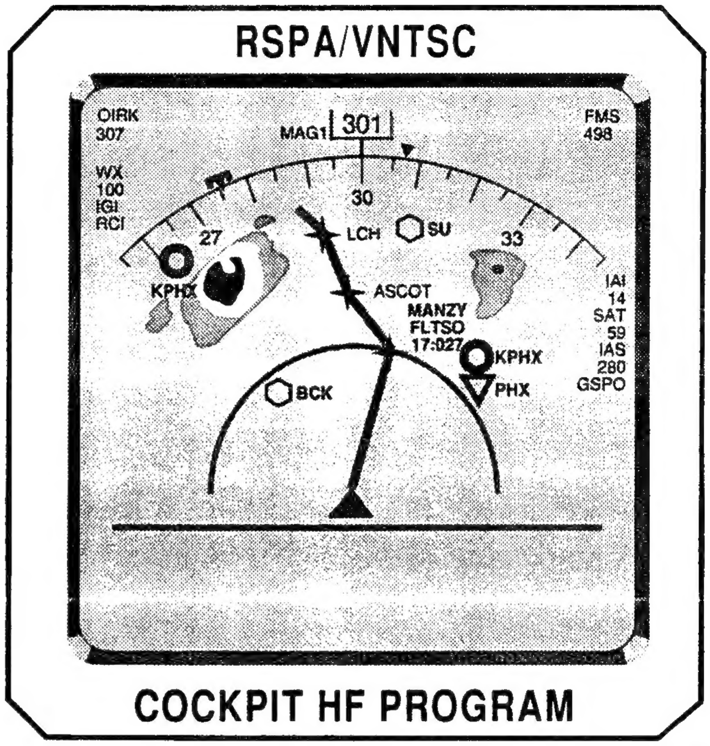
An Exploratory Survey of Information Requirements for Instrument Approach Charts



R. John Hansman, Jr.
Mark Mykityshyn

Aeronautical Systems Laboratory
Department of Aeronautics & Astronautics
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

Final Report
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R. John Hansman, Jr., Mark Mykityshyn

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13. ABSTRACT (Maximum 200 words)

This report documents a user centered survey and interview effort conducted to analyze the information content of current Instrument Approach Plates (IAP). In the pilot opinion survey of approach chart information requirements, respondents indicated their preferences for approach information and at what phase of the approach they preferred to see this information. Both precision and non-precision IAP formats were examined. In addition to the survey, focused interviews were conducted with pilots who represent the full spectrum of operational IAP user communities from major domestic air carriers to general aviation.

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PREFACE

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The authors would also like to recognize the contribution made to this report by Ricardo Paxson. His patience, cooperation, initiative, and truly *outstanding* work were sincerely appreciated.

METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in)	= 2.5 centimeters (cm)
1 foot (ft)	= 30 centimeters (cm)
1 yard (yd)	= 0.9 meter (m)
1 mile (mi)	= 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2)	= 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2)	= 0.09 square meter (m^2)
1 square yard (sq yd, yd^2)	= 0.8 square meter (m^2)
1 square mile (sq mi, mi^2)	= 2.6 square kilometers (km^2)
1 acre = 0.4 hectare (he)	= 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz)	= 28 grams (gm)
1 pound (lb)	= 0.45 kilogram (kg)
1 short ton = 2,000 pounds (lb)	= 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp)	= 5 milliliters (ml)
1 tablespoon (tbsp)	= 15 milliliters (ml)
1 fluid ounce (fl oz)	= 30 milliliters (ml)
1 cup (c)	= 0.24 liter (l)
1 pint (pt)	= 0.47 liter (l)
1 quart (qt)	= 0.96 liter (l)
1 gallon (gal)	= 3.8 liters (l)
1 cubic foot (cu ft, ft^3)	= 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3)	= 0.76 cubic meter (m^3)

TEMPERATURE (EXACT)

[(x-32)(5/9)] °F = y °C

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm)	= 0.04 inch (in)
1 centimeter (cm)	= 0.4 inch (in)
1 meter (m)	= 3.3 feet (ft)
1 meter (m)	= 1.1 yards (yd)
1 kilometer (k)	= 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2)	= 0.16 square inch (sq in, in^2)
1 square meter (m^2)	= 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2)	= 0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2)	= 1 hectare (he) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm)	= 0.036 ounce (oz)
1 kilogram (kg)	= 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg)	= 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml)	= 0.03 fluid ounce (fl oz)
1 liter (l)	= 2.1 pints (pt)
1 liter (l)	= 1.06 quarts (qt)
1 liter (l)	= 0.26 gallon (gal)
1 cubic meter (m^3)	= 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3)	= 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

[(9/5) y + 32] °C = x °F

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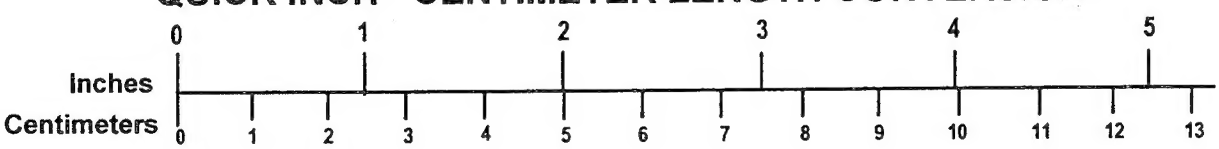

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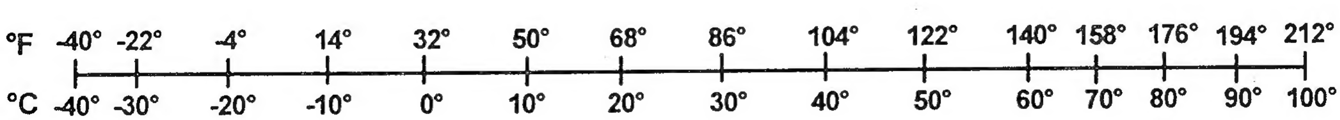

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TABLE OF CONTENTS

Section			Page
1.	INTRODUCTION		1
2.	APPROACH		3
3.	SURVEY DESIGN		5
	3.1	Survey Section I: (Background Information)	5
		3.1.1 Personal Information	5
		3.1.2 Flight Time and Experience	6
		3.1.3 Pilot Ratings Held	6
	3.2	Survey Section II: (General IAP Usage)	6
		3.2.1 IAP Experience and Opinions on Chart Format	6
		3.2.2 Information Contained on an IAP	7
		3.2.3 Contributions to Chart Clutter	7
		3.2.4 Operator Preferences	7
	3.3	Survey Section III: (Approach Plate Information Analysis)	7
		3.3.1 Phases of Flight	9
		3.3.2 Procedure	10
	3.4	Survey Section IV: (Electronic Instrument Approach Plates)	10
		3.4.1 Preferences for Electronic Instrument Approach Plates	13
		3.4.2 Customization of the IAP	13
4.	DISCUSSION AND FINDINGS		15
	4.1	Survey Section I: (Background Information)	15
		4.1.1 Personal Information	15
		4.1.2 Flight Time and Experience	16
		4.1.3 Pilot Ratings Held	17
	4.2	Section II: (General IAP Usage)	17
		4.2.1 Information Contained on an IAP	17
		4.2.2 IAP Experience and Opinion on Chart Format	19
		4.2.3 Operator Preferences	22

TABLE OF CONTENTS (cont.)

Section **Page**

4.3 Survey Section III: (Approach Plate Information Analysis) 23

4.3.1 Procedure 23
4.3.2 Information Element Categories Identified 24
4.3.3 Tracking the Flow of Information Elements: Precision Approach . . 29

4.3.3.1 IAP Area A: Communication Frequencies and Airport Identification Information 32
4.3.3.2 IAP Area B: Plan-View Depiction of the Terminal Area 36
4.3.3.3 IAP Area C: Profile Depiction of the Terminal Area 38
4.3.3.4 IAP Area D: Instrument Approach Procedure Minimums . 40

4.3.4 Tracking the Flow of Information Elements: Non-Precision Approach 41

4.3.4.1 IAP Area A: Communication Frequencies and Airport Identification Information 44
4.3.4.2 IAP Area B: Plan-View Depiction of the Terminal Area . . 45
4.3.4.3 IAP Area C: Profile Depiction of the Terminal Area 46
4.3.4.4 IAP Area D: Instrument Approach Procedure Minimums 47

4.3.5 Comparison of Information Requirements: Precision vs. Non-Precision Approach 48
4.3.6 Comparison of Information Requirements ("Glass-Cockpit" Subgroup vs. General Respondent Group) 51

4.4 Survey Section IV: (Electronic Instrument Approach Plates) 52

4.4.1 Preferences for Electronic Charts 52
4.4.2 Customizing of the IAP 53

5. CONCLUSIONS 55

REFERENCES 57

TABLE OF CONTENTS (cont.)

Section		Page
APPENDIX A	Survey of Approach Chart Information Requirements	A-1
APPENDIX B	Information Element Key — Precision Approach	B-1
APPENDIX C	Information Element Key — Non-Precision Approach	C-1
APPENDIX D	Information Element Ranking per Phase of Flight — Precision Approach	D-1
APPENDIX E	Information Element Ranking per Phase of Flight — Non-Precision Approach	E-1
APPENDIX F	Net Interest Ranking Curves — Precision Approach	F-1
APPENDIX G	Net Interest Ranking Curves — Non-Precision Approach	G-1
APPENDIX H	Preferred Information Elements per Phase of Flight — Precision Approach	H-1
APPENDIX I	Preferred Information Elements per Phase of Flight — Non-Precision Approach	I-1
APPENDIX J	Net Interest Ranking Curves — "Glass-Cockpit" Subgroup	J-1

LIST OF FIGURES

Figure		Page
3-1	Factors Contributing to Chart Clutter	8
3-2	Jeppesen Sanderson Precision Approach Format	11
3-3	Highlighting Exercise Illustration	12
4-1	Information Element (All) Ranking	26
4-2	Net Interest Ranking Curve	27
4-3A/B	Information Element Selection: Precision Approach	28
4-4A/B	Information Element Selection: Non-Precision Approach	30
4-5	Area Composition of an IAP	31
4-6	Information Elements Flow Chart — Precision Approach	33
4-7	Preferred Information Elements Per Phase of Flight — Precision Approach	34
4-8	Information Elements Flow Chart — Non-Precision Approach	42
4-9	Preferred Information Elements Per Phase of Flight — Non-Precision Approach	43

LIST OF TABLES

Table		Page
4-1	Personal Information	15
4-2	Pilot Flight Time and Experience	16
4-3	Pilot Ratings Held	17
4-4	Results of IAP Opinions	18
4-5	IAP Experience	19
4-6	Chart Clutter	21
4-7	Operator Preferences	23
4-8	Comparison of Information Requirements: Precision vs. Non-Precision Approach	48
4-9	Table of Comparison: "Glass Cockpit" Subgroup vs. General Respondent Group	51
4-10	Preferences for Electronic Charts	52
4-11	Customizing the IAP	54

LIST OF ACRONYMS

AGL	Above Ground Level
ATP	Airline Transport
DH	Decision Height
DOD	Department of Defense
EHSI	Electronic Horizontal Situation Indicator
FAA	Federal Aviation Administration
FAC	Final Approach Course
FAF	Final Approach Fix
FE	Flight Engineer
FMC	Flight Management Computer
GS	Glide Slope
IAF	Initial Approach Fix
IAP	Instrument Plates
IFR	Instrument Flight Rules
ILS	Instrument Landing System
LOC	Localizer
LOM	Locator at the Outer Marker
LORAN	Long Range Navigation
MAP	Missed Approach Point
MDA	Minimum Descent Altitude
MM	Middle Marker
MSA	Minimum Safe Altitude
MSL	Mean Sea Level
NAVAID	Navigational Aid
NDB	Non-Directional Beacon
NOAA	National Oceanic Atmospheric Administration
NOTAM	Notice To Airmen
TERPS	Terminal Instrument Procedures
VFR	Visual Flight Rules

EXECUTIVE SUMMARY

This report documents a user-centered survey and interview effort conducted to analyze the information content of current Instrument Approach Plates (IAP's). The analysis included data from a pilot opinion survey of approach chart information requirements. It is important to note that the survey attained a low response rate (9.7%, 29 respondents) that is thought to be attributed to the extensive nature of the survey, which required approximately 1.5 hours to complete. Therefore, the respondents are self-selected, and their data may not be fully representative of the general user group.

Both precision and non-precision IAP formats were examined. Respondents indicated their preferences for approach information and when (at what point during the execution of the approach procedure) they preferred to see this information.

In addition to the survey, focused interviews were conducted with pilots who represent the full spectrum of operational IAP user communities from major domestic air carriers to general aviation.

These investigations resulted in the following findings:

1. A substantial number (93%) of pilots felt that it was possible to make operational errors in the cockpit that can be attributed to charting considerations; however, a majority (59%) indicated that a major change in IAP format is neither warranted nor desired.

2. Differences in instrument approach information requirements indicate that preferences for this information change as the pilot progresses through various phases of flight during the execution of an instrument approach procedure.

3. Depiction of terrain information on the IAP is a low priority. A vast majority of survey respondents (80%) indicated that a reduction in the amount of terrain information depicted on current IAP formats is desired.

   Pilots did, however, express a desire to have Minimum Safe Altitude (MSA) information available. This may indicate that pilots desire to have some form of terrain information depicted, but do not agree with the manner in which it is currently depicted on the IAP.

4. Pilot information requirements suggest that the profile view of the IAP provides the pilot with the primary vertical guidance and navigation information during the approach phase of flight of an instrument procedure for both precision and non-precision formats.

5. A vast majority of the respondent group (70%) were in favor of electronic replication of current IAP formats. However, respondents expressed concern about system reliability; only 31% indicated that they would be comfortable using an electronic IAP format without a paper IAP backup.

6. Information requirements of the general respondent group were compared to those of a subgroup comprised of pilots with experience in advanced automated, "glass-cockpit" aircraft. The quantity and content of the information most desired by both groups indicated that no substantial differences exist in their respective information requirements.

1. INTRODUCTION

This effort, conducted under DOT TSC contract DTRS-57-88-C-00078 on the design and evaluation of aeronautical charts, documents an analysis of the information content of current Instrument Approach Charts, referred to as Instrument Approach Plates (IAP's).

Due to limitations in display technology, electronic replication of Instrument Approach Plates may limit the amount of approach information available to the pilot at any particular point in the execution of a published instrument approach procedure. The primary focus of this effort was to evaluate the relative importance of approach chart information as a function of phase of flight. In addition, the flow of information used by the respondent pilot group per phase of flight was observed and noted.

2. APPROACH

The approach consisted of two components. A user-centered survey of IAP information requirements (Appendix A) was distributed to a multi-faceted group of operational IAP users. This group of pilots was selected to represent the full spectrum of IAP users from major domestic air carriers to general aviation. It is important to note, however, that the low survey response rate (9.7%, 29 respondents) is thought to be attributed to the extensive nature of the survey. The respondents are, therefore, self-selected, and their data may not be fully representative of the general user group.

The second component consisted of focused interviews with operational IAP users representing the aviation communities listed above. In addition, FAA representatives from Flight Crew Human Factors and the Office of Aviation Medicine were consulted. At the request of some of those interviewed, names and affiliations have been withheld. The interviews were conducted from a directed question list by experienced aviators familiar with IFR operations and instrument flight procedures. Findings from these interviews have been incorporated in Section 4.

3. SURVEY DESIGN

The user-centered survey consisted of four parts. A brief description and background was provided as an introduction to each individual section. Section I (Background) consisted of questions concerning the respondents' aviation background. Section II (General IAP Usage) asked pilots to describe their preferences concerning utilization of information contained on current Instrument Approach Plates. In Section III (Approach Plate Information Analysis), respondents were presented with sample precision and non-precision IAP's and asked to separately identify, per phase of flight, the approach information they felt was critical (and extraneous) to complete that particular phase of flight. Section IV (Electronic Approach Charts), the final section of the survey, concerned individual preferences regarding electronic Instrument Approach Plates. The responses to all survey questions (Sections I, II, and IV) are summarized and discussed in Section 4.

3.1 SURVEY SECTION I: (BACKGROUND INFORMATION)

Information concerning the aviation background of the respondents was solicited in the following three areas in an attempt to more accurately assess the variables that affect pilot preferences.

3.1.1 Personal Information

In addition to providing their sex and age, respondents were asked to indicate their highest level of education. In order to determine if those with a more advanced mathematics background would be more receptive to the use of a new form of electronic cockpit instrumentation, pilots were asked to indicate the highest level of mathematics preparation attained. Respondents were also asked to indicate any familiarity they have with computer systems, and/or experience (if any) they possess with Flight Management Computer (FMC) equipped aircraft.

3.1.2 Flight Time and Experience

This part of the survey sought to determine how the respondents received their initial flight training (civil or military), total flight time accumulated to date, and flight experience by aircraft type. From this data, operators of advanced automated, "glass-cockpit" aircraft were identified. In order to determine the current level of flight proficiency maintained by the population, respondents were asked to indicate the number of flight hours accumulated during the past year.

3.1.3 Pilot Ratings Held

Respondents were asked to indicate the various ratings they have attained throughout their aviation careers.

3.2 SURVEY SECTION II: (GENERAL IAP USAGE)

The purpose of this section was to evaluate the information content of the two most widely used domestic IAP formats: Jeppesen-Sanderson Inc., and the U.S. government (NOAA and the Department of Defense in conjunction with the FAA). The survey solicited responses in the following four areas.

3.2.1 IAP Experience and Opinions on Chart Format

It was desirable to determine the baseline IAP experience level possessed by the respondents. Currently, all military aviators use NOAA/DOD charts. Since the survey was partially distributed through the military reserves, a higher percentage of the respondents used both NOAA and Jeppesen-Sanderson IAP's than may be expected in the general population. In addition, respondents were asked to indicate whether or not a major change in approach chart format was either warranted or desired.

3.2.2 Information Contained on an IAP

It was desirable to solicit pilot opinion concerning the amount of time spent interpreting information while in the terminal area, and the possibility of cockpit error due to charting considerations. In addition, respondents were asked to describe the differences (if any) in the presentation of information they require in order to execute a precision and a non-precision instrument approach procedure.

3.2.3 Contributions to Chart Clutter

Chart clutter can degrade pilot performance by detracting from the pilot's ability to extract the relevant IAP information necessary to execute a published instrument approach procedure. A non-exhaustive list of categories of information that contribute to chart clutter were constructed. An example from each category is depicted on the following page in Figure 3-1. Pilots were asked to indicate on a scale from 1 (No contribution to clutter) to 5 (Significant contribution to clutter) how much each category contributed to chart clutter. Results are depicted in Table 4-6.

3.2.4 Operator Preferences

These questions sought to determine pilot opinion concerning the relative importance of IAP's in VFR flight conditions. In addition, respondents were asked to indicate if they used a standard pre-approach brief, and if so, to describe their briefing procedure.

3.3 SURVEY SECTION III: (APPROACH PLATE INFORMATION ANALYSIS)

This section was the primary focus of the survey. Here, crew preferences regarding the use of IAP information per phase of flight in the execution of a published instrument approach procedure were investigated. Before proceeding with the analysis of pilot information preferences per phase of flight, certain components used for the analysis were selected, constructed, and designed.

NOT FOR NAVIGATION

Information Categories Contributing to Chart Clutter

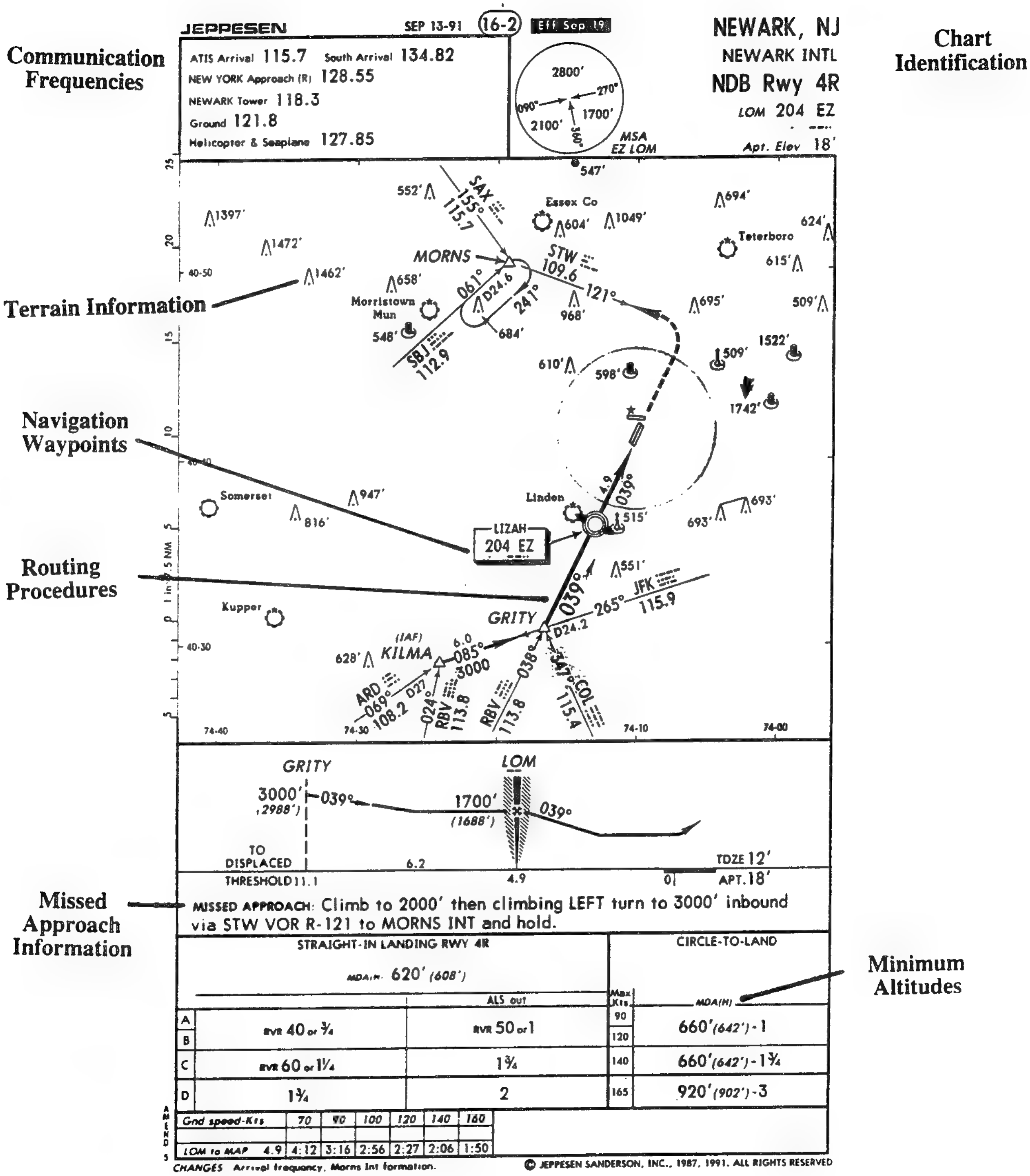

FIGURE 3-1. FACTORS CONTRIBUTING TO CHART CLUTTER

3.3.1 Phases Of Flight

The instrument approach procedure was divided into four phases of flight according to the definitions listed below. Although these four phases were subjectively constructed, they remain constant for both precision and non-precision approaches and are consistent with those as outlined in the United States Standard for Terminal Instrument Procedures (TERPS) manual.

1. Pre-Approach

   This consists largely of a procedure review *prior* to execution of the instrument approach procedure.

2. Approach (Execution of the instrument approach procedure)

   The actual execution of the depicted procedure from terminal area entry to the decision height (DH) for a precision approach, or to the minimum descent altitude (MDA) for a non-precision approach.

3. Missed Approach (If required)

   If, at the missed approach point (MAP), the aircraft cannot be safely landed, the pilot will execute a missed approach procedure which may entail entry into a holding pattern for another approach.

4. Ground Operations* (Taxi for take-off, taxi to parking)

   Ground operations are an important phase of the approach especially for inexperienced pilots operating at a busy airport. Of particular interest during this

---

* Due to an oversight when the survey was initially distributed, an airfield diagram was not included. Therefore, an accurate reflection of pilot preferences regarding this information could not be obtained.

phase of the procedure is the enormous number of surface features depicted on airfield diagrams.

3.3.2 Procedure

Respondents were asked to indicate their preferences concerning instrument approach information elements per phase of flight according to the definitions provided above. For each phase of flight, they were provided with a precision and a non-precision IAP. Jeppesen-Sanderson IAP's were selected for this effort because they are used by the majority of the civil aviation community. In addition, the critical elements are essentially the same for both NOAA and Jeppesen-Sanderson IAP's; therefore, the same results should be applicable to both.

There were a variety of non-precision approaches from which to choose for this effort. An NDB approach (Figure 3-1) was chosen as a representative non-precision approach. The ILS 13L approach to Kennedy International Airport (Figure 3-2) was selected as the precision approach.

Equipped with two highlighters (yellow and pink), respondents indicated their preferences for approach information by highlighting (in yellow) the information they felt was critical to have access to during each respective phase of flight. Highlighting in pink indicated the information they would suppress if afforded the opportunity to customize their IAP. Information which the pilot felt was neither critical enough to have access to, nor undesirable enough to suppress, was *not* highlighted. Figure 3-3 depicts a representative IAP resulting from this procedure.

3.4 SURVEY SECTION IV: (ELECTRONIC INSTRUMENT APPROACH PLATES)

Due to limitations in display technology, electronic replication of paper instrument approach plates may limit the amount of approach information available to the pilot at any particular time during the execution of a published instrument approach procedure.

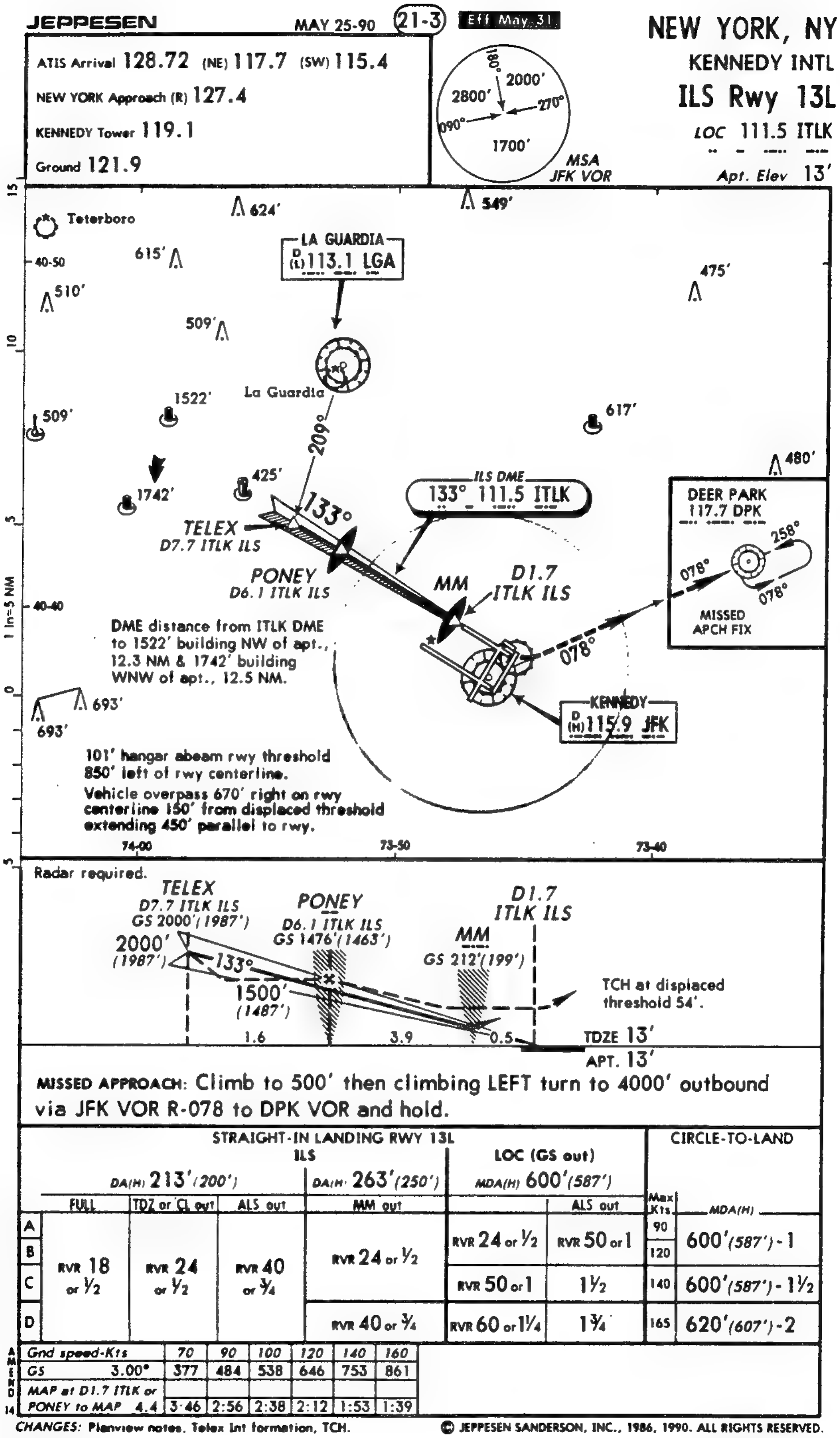

FIGURE 3-2. JEPPESEN SANDERSON PRECISION APPROACH FORMAT

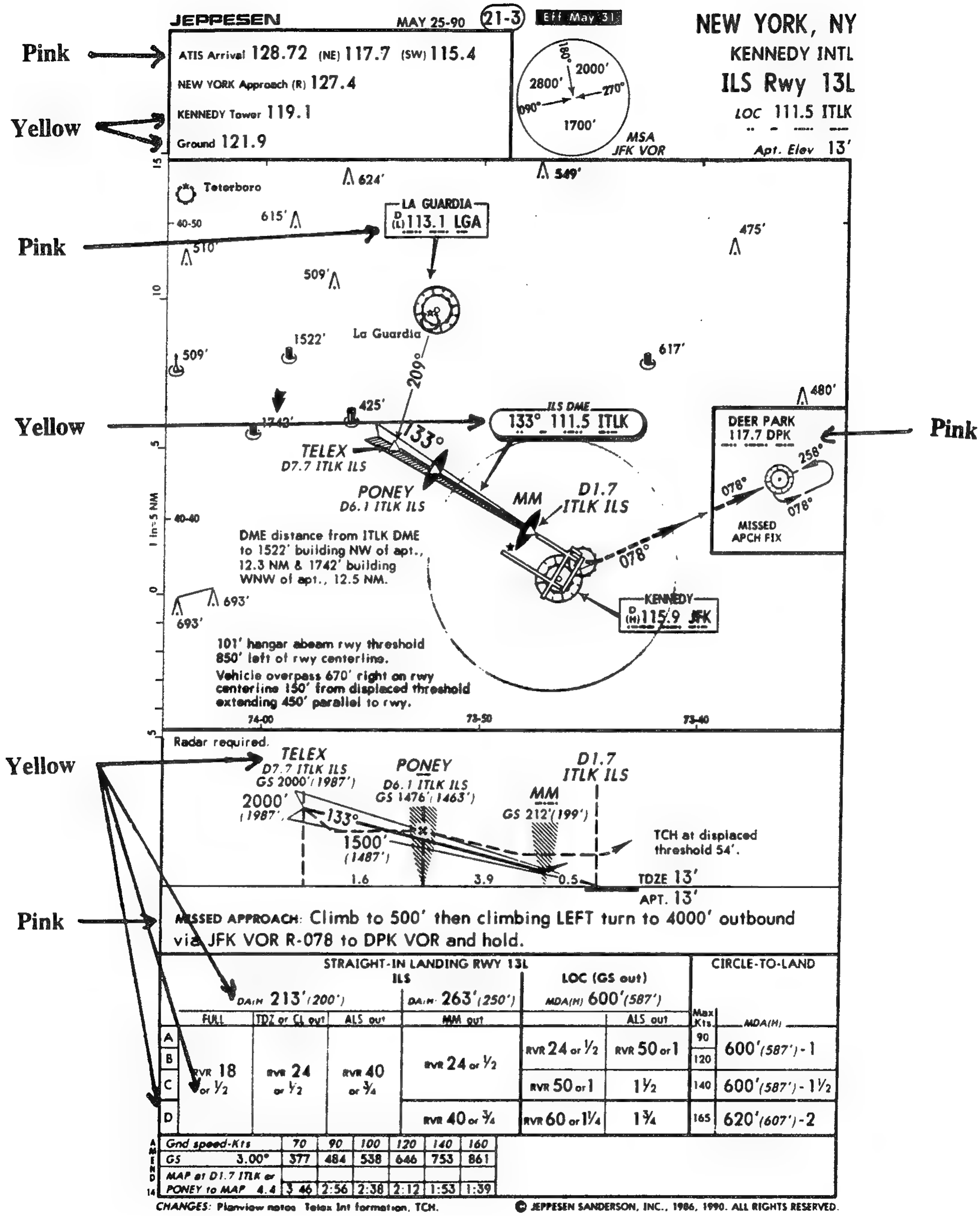

FIGURE 3-3. HIGHLIGHTING EXERCISE ILLUSTRATION

However, electronic approach plates may also provide the pilot with the flexibility to select only the desired approach information. This section of the survey solicited responses in the following two areas.

3.4.1 Preferences for Electronic Instrument Approach Plates

These questions sought to determine operator preferences, given the available technology, regarding some of the options currently available for electronic replication of Instrument Approach Plates.

3.4.2 Customization of the IAP

Customizing the IAP affords the pilot the opportunity to select only desired approach information. It was desired to determine if pilots are receptive to customizing their own IAP's, and to solicit their opinions concerning some of the issues that arise from this procedure. Some of these issues include workload considerations, and the differences *(if any) concerning information requirements for manual versus autoflight operations.*

4. DISCUSSION AND FINDINGS

The results of the survey and interview effort discussed above were organized into four areas corresponding to the four sections of the survey and are presented below.

4.1 SURVEY SECTION I: (BACKGROUND INFORMATION)

Information concerning the aviation background of the respondents was solicited in the following areas in order to more accurately assess the variables that affect pilot preferences.

4.1.1 Personal Information

The respondent group consisted of pilots representing a multitude of aviation experience. Of the 300 surveys that were distributed, 29 responses were generated. In order to determine if those with an advanced knowledge of software packages would be more receptive to the use of a new form of electronic cockpit instrumentation, pilots were asked to indicate their knowledge of software packages (Table 4-1).

TABLE 4-1. PERSONAL INFORMATION	
Average Age	39
Sex	96% Male
Education Level	93% Possess At least a College Degree
Math level	4.4 (1=Arithmetic; 5=Beyond Calculus)
Computer Experience	2.9 (1=No Cmptr. Exper.; 5=Much Cmptr.Exper.)

The average respondent is a 39-year-old male (1 female responded). Collectively, the group is well educated; over 90% of the respondents possess at least a college degree. On a scale

of 1 (Arithmetic) to 5 (Beyond Calculus), respondents were asked to indicate their level of math experience. Their response (4.4) was indicative of preparation somewhere between calculus and beyond calculus. On a scale from 1 (No knowledge of software packages) to 5 (Knowledge of several software packages), respondents indicated (2.9) that they possess an average knowledge of computer software packages.

4.1.2 <u>Flight Time and Experience</u>

All respondents are fixed wing pilots averaging 4948 total flight hours; one pilot accumulated additional rotary wing experience. Table 4-2 contains a flight time and experience summation of the respondent group.

TABLE 4-2. PILOT FLIGHT TIME AND EXPERIENCE

Initial Training Flight Received	55% Civil
Civil Flight Time (Total)	2982 Hours
Civil Experience by Aircraft Type	100% Fix Wing
FMC Experience	34.4% Yes
"Glass-Cockpit" Experience	17.3% Yes
Military Flight Time	1966 65.5% Military
Current Military Reserve Status	44.8 % Yes
1989 Flight Hours (Average)	421.2 Hours

Initial aviation training among the respondents is relatively balanced; 55% received their flight training in a civilian capacity, while the rest were trained as either U.S. Naval or Air Force aviators. Of the 45% that received their initial flight experience from the military, almost the entire group (44.8%) currently flies in a military reserve capacity. As was previously noted, because the survey was partially distributed through the military reserves, this figure may be artificially high.

Users of advanced automated, or glass-cockpit aircraft comprised a small (17.3%) subgroup of the general respondent group. The glass-cockpit respondents averaged 1180 hours in Flight Management Computer (FMC) equipped aircraft. Information preferences between those with glass-cockpit flight experience and the general respondent group are compared in Section 4.3.6.

4.1.3 Pilot Ratings Held

Respondents were asked to indicate the various ratings they have attained throughout their aviation careers. Table 4-3 contains a summation of these ratings.

TABLE 4-3. PILOT RATINGS HELD

Fix Wing Airline Transport (ATP)	82.7% Yes * Higher than the General Population
Fix Wing Commercial Pilot	58.66% Yes
Fix Wing Flight Engineer (FE) Written	41.4% Yes
Rotary Wing Commercial Pilot	3.4% Yes

4.2 SECTION II: (GENERAL IAP USAGE)

The purpose of this section was to evaluate the information content of the two most widely used domestic IAP formats: Jeppesen-Sanderson Inc., and the U.S. government (NOAA and the Department of Defense in conjunction with the FAA). In this section, no attempt was made to identify specific informational usage patterns per phase of flight.

4.2.1 Information Contained on an IAP

Operational IAP users representing various aviation communities have indicated that IAP's can contain both "too much" and "too little" information at the same time. When it is most desired (phase of flight), respondents contend that the critical information contained on the

IAP requires a substantial amount of time and effort to locate. On a scale from 1 ("Not enough information") to 5 ("Too much information"), pilots indicated (3.62) that the current IAP's are relatively information dense. One respondent noted that:

> *"...This question must consider phase of flight. Lots of information and a "busy" chart may be o.k. in the pre-approach phase (after receiving the ATIS but still in cruise or early descent), but the chart clutter becomes a major handicap as the approach progresses. You must also consider ambient lighting and flight conditions. When you are sitting at a desk in good light with all the time you need, the chart looks fine to you. If I'm looking at a chart at night in poor lighting conditions and flying in light turbulence and I'm in a hurry, I can't find the information I need..."*

A large percentage of respondents (47.4%) indicated that confusion between the primary and secondary NAVAID frequency is not at all uncommon. Table 4-4 contains a summation of pilot opinion concerning the information contained on an IAP.

TABLE 4-4. RESULTS OF IAP OPINIONS

Quantity of IAP Information Presented	3.62 (1= Not Enough Info.; 5= Too Much Info)
Info Req for Precision/Non-Precision	63.2% Yes
Average Time Selecting Information	2.4 (1=Acceptable; 5= Unacceptable)
Maximum Time Selecting Information	2.5 (1=Acceptable; 5= Unacceptable)
Interpretation of Critical Information	2.4 (1=Never; 5= Always)
Chart Errors in Low vs. Bright Light	100% Low
Confusion of Primary/Secondary NAVAID	47.4% Yes
Experience With LORAN Approaches	10.5% Yes
Problems Encountered With LORAN	10.5% Yes

Pilot opinions were solicited in order to determine if those pilots who used both NOAA and Jeppesen-Sanderson IAP formats experienced any difficulties when switching back and forth between formats. An examination of comments provided by the respondent group indicated that some minor difficulties do exist.

4.2.2 IAP Experience and Opinion On Chart Format

The survey was designed to accommodate a multitude of civil and military aviation experiences. Although (currently) all military aviators use DOD charts, the vast majority of civil aviation communities use Jeppesen-Sanderson IAP's. While nearly 60% of our respondent group have used NOAA/DOD charts for the majority of their flight experience, 70% currently use Jeppesen-Sanderson IAP's. Due to the partial distribution of the survey through the military reserves, these high NOAA/DOD percentages may be an artifact from that distribution. Table 4-5 contains a summation of operator IAP experience.

The majority of respondents (78.9%) indicated that they follow procedures which allow them to have access to a full set of NOTAM information. In addition, on a scale from 1 (Never) to 5 (Frequently), respondents indicated that they have rarely observed (2.1) anyone using outdated or non-current charts.

TABLE 4-5. IAP EXPERIENCE

IAP Experience by Chart	41.4% Jeppesen-Sanderson
IAP Most Currently Used	70% Jeppesen-Sanderson
Access to a Full Set of NOTAMS	78.9% Yes
Non-Current Chart Usage	2.2 (1 = Never; 5 =Frequently)
Cockpit Errors Due to Charts	93.1% Yes
Major Change in Format Desired	59% No

Terminal instrument procedures are conducted at low altitudes with a small margin for error. An overwhelming percentage of respondents (93.1%) acknowledged that errors in the cockpit can be attributed to charting considerations; however, a majority (59%) indicated that a new IAP format is neither warranted nor desired.

Focused interviews were conducted to augment the information that was obtained from the survey. Some of those interviewed felt that chart clutter was the leading cause of cockpit error. Most pilots agreed that errors of this nature are entirely possible, but felt that additional preparation before entering the terminal area might reduce their chances of making "common" errors. Misinterpretation of communication frequencies was cited as an example of a "common" error.

When presented with a scenario that entailed a change in the active runway either just prior to or within the terminal area, one interviewee expressed concern about the effort required to locate the useful information *now* required to execute the new approach procedure:

> *"...The problem lies not only in the time it takes to find the information, but the effort required to find it (especially if it's in small print) among all the clutter...the IAP is so cluttered now that sometimes you miss things that are really important. It needs to be cleaned up..."*

Table 4-6 depicts pilot opinions regarding information categories that contribute to chart clutter.

On a scale from 1 (No contribution to chart clutter) to 5 (Significant contribution to chart clutter), respondents indicated that the highest contribution to chart clutter (3.7) was terrain information. When asked how they would reduce the amount of terrain information contained on IAP's, mixed responses were generated. They ranged anywhere from removing terrain information altogether from the IAP, to increasing the amount of terrain information; for example, this statement:

TABLE 4-6. CHART CLUTTER	
Chart Identification Information	1.1 (1= no chart clutter; 5= significant clutter)
Airport Information	1.7 (1= no chart clutter; 5= significant clutter)
Terrain Information	3.6 (1= no chart clutter; 5= significant clutter)
Navigation Waypoints	2.7 (1= no chart clutter; 5= significant clutter)
Routing Procedures	1.9 (1= no chart clutter; 5= significant clutter)
Missed Approach Information	1.5 (1= no chart clutter; 5= significant clutter)
Communication Frequencies	1.8 (1= no chart clutter; 5= significant clutter)
Procedure Minimum Altitudes	2.2 (1= no chart clutter; 5= significant clutter)
Inc/Dec Terrain Information on IAP	84.3% Decrease

> *"...For my purposes, remove terrain information from the IAP entirely. Give me a single, close-in area chart showing terrain and significant geographic features within 20 nautical miles of the airport. Use color and make it look like a sectional chart ... I can look that over while in cruise. I don't need or want that information on the IAP..."*

Over 80% of the respondent group indicated that they would like to see the amount of terrain information contained on an IAP reduced. Focused interviews were conducted to solicit additional information regarding the depiction of terrain information.

Those interviewed responded with a wide variety of comments. One interviewee acknowledged:

> *"...Too much undesirable information contained on the plate in the form of transition altitudes, spot-elevations, and other terrain information that should be excluded...Just give me the MSA and I have all the obstacle clearance information I need..."*

However, the interviewee also offered that he felt this information may be a permanent fixture on an IAP:

> *"...but I can see the perspective of the chart manufacturer, too. If I didn't include that tower on the approach plate and somebody goes out there and hits it, I'm in for some trouble..."*

Most of those interviewed indicated that IAP's were especially difficult to read under low lighting conditions, and in turbulent weather. Users indicated that the charts could be made more readable by "getting rid" of some information and increasing the size of the print. Suggestions ranged from the removal of all transition information and altitudes (except "own" category procedure minimums) to adding more Enroute (IFR) Supplement information to the IAP.

Those interviewed were questioned about the removal of non-pertinent procedure minimum altitudes (those that pertain to "all other" category aircraft) presented at the bottom of IAP formats. All agreed that it was not necessary to "see" procedure minimum attitudes that do not pertain to his/her "own" category aircraft; however, they also agreed that it *was* important to have those minimum procedure altitudes that describe abnormal operating procedures. Some examples of these minimum altitudes are "LOC (Glide Slope [GS] out)," or "Middle Marker (MM) out."

4.2.3 Operator Preferences

These questions were asked in an attempt to generate pilot opinion regarding the use of approach information prior to the execution of the instrument approach procedure. In addition, pilots were asked to comment on how (if at all) they use the IAP while operating in VFR flight conditions. A summation of responses is provided in Table 4-7.

TABLE 4-7. OPERATOR PREFERENCES	
Brief of Both Type IAP's	74.1% Yes
Brief as Initially Trained	52.2% Yes
Required to Brief in a Specified Manner	75.8% Yes
Use of IAP in VFR Conditions	89.7% Yes

Most (89.7%) of the pilots indicated that they use the IAP as a reference/backup when conducting flight operations in VFR conditions. A vast majority of respondents (75.8%) are required to brief the instrument approach procedure in a specific manner.

4.3 SURVEY SECTION III: (APPROACH PLATE INFORMATION ANALYSIS)

In this section, crew preferences regarding the use of IAP information per phase of flight in the execution of a published instrument approach procedure were investigated. The flow of preferred information changes as a pilot progresses through the various phases of an instrument approach procedure. Information elements may overlap, if not altogether change. The flow of information may also change from precision to non-precision approaches.

4.3.1 Procedure

In order to tabulate pilot preferences concerning instrument approach information, it was first necessary to define an information element. This was the primary unit of measure used throughout this section. Information elements were used by the pilot throughout this procedure to indicate preferences during the execution of an instrument approach procedure.

As it pertains to an IAP, an information element can be defined as a quantity of information that cannot be subdivided and still have utility in the completion of the task at hand. Taken in this context, an example of an information element is a localizer frequency for an instrument landing system (ILS) approach. Procedurally, for the pilot to correctly execute the

ILS approach, both the numerical frequency itself and its identity as the localizer frequency as well must be specified for the element to be useful.

Though the frequency itself consists of several digits and a decimal point which would require a certain number of bits to code in an engineering system, the whole frequency has no useful meaning to the pilot except as a *complete* element. Note here that the specific coding method used to present an information element may be mixed within the element. For example, the localizer numerical frequency itself may be presented with alphanumeric text, but its identification as the localizer frequency may be indicated by its location on the approach chart, the type font used for the frequency, or with a symbol. Because an information element is defined by utility (which depends upon the task being performed), it is difficult to develop a strict criterion that can be used to identify information elements across widely different tasks. However, by recognizing each information element as being well-defined for a given task, our analysis was predicated on this information element definition as an initial assumption.

The information elements on the precision and non-precision IAP's used in the survey were identified by circling and numbering them. Information element requirements per phase of flight were tabulated according to the procedure outlined in Section 3.3.2. The actual IAP and a key describing each numbered element for both the precision and non-precision IAP are contained in Appendices B and C, respectively.

4.3.2 Information Element Categories Identified

Initially, "yes" responses (indicating that the element was critical) were determined for each information element. In the same fashion, "no" responses (information elements that would be suppressed if afforded the opportunity to do so) were determined. "Yes" minus "no" responses were then calculated in order to generate a "Net Interest Ranking" for each information element. A value of "0" means that an equal number of respondents indicated "yes" and "no" to the information element. This procedure was conducted for each phase of flight for both the precision and non-precision approach. The Net Interest Ranking was then

used as a criteria for ranking all information elements per phase of flight. Rankings for all precision approach information elements are contained in Appendix D; the same ranking for all non-precision approach information elements is contained in Appendix E. Figure 4-1 shows an example of this information element ranking for the pre-approach phase of the precision approach.

In order to to identify critical information elements per phase of flight, all information elements (in order of rank) were plotted against the Net Interest Ranking. Figure 4-2 depicts an example of this procedure. Each curve per phase of flight for both the precision and the non-precision approach exhibited the same general characteristics that include a plateau near "0" Net Interest Ranking and two discernable "knees." These characteristics were used in order to develop a subjective methodology for the establishment of a "threshold"; i.e., a baseline used to separate the various categories of instrument approach information presented to the pilot. An example of this methodology is presented in Figure 4-2.

The most critical instrument approach information required by the pilot to successfully complete an approach procedure was attained by identifying the first knee in the curve. Elements above this knee (the highest ranking information elements) will be referred throughout this effort as "preferred" information elements. Following the same methodology, elements falling below the the second discernable knee in the curve are referred to as "low." Elements that lie in the plateau region between the two knees are identified as "neutral" elements. The preferred and low thresholds were determined for each phase of flight for both the precision and non-precision approaches, and are contained in Appendices F and G, respectively. Only the preferred information elements per phase of flight for both the precision and non-precision approach were tabulated and are presented in Appendices H and I, respectively.

In order to better reflect the selection of information elements by the respondent pilot population, sample IAP's which included selected information elements were generated. Figure 4-3a depicts only the preferred information elements. Figure 4-3b depicts pilot preferences for preferred *plus* neutral information elements. These sample IAP's were

Precision Approach

Pre-Approach Phase

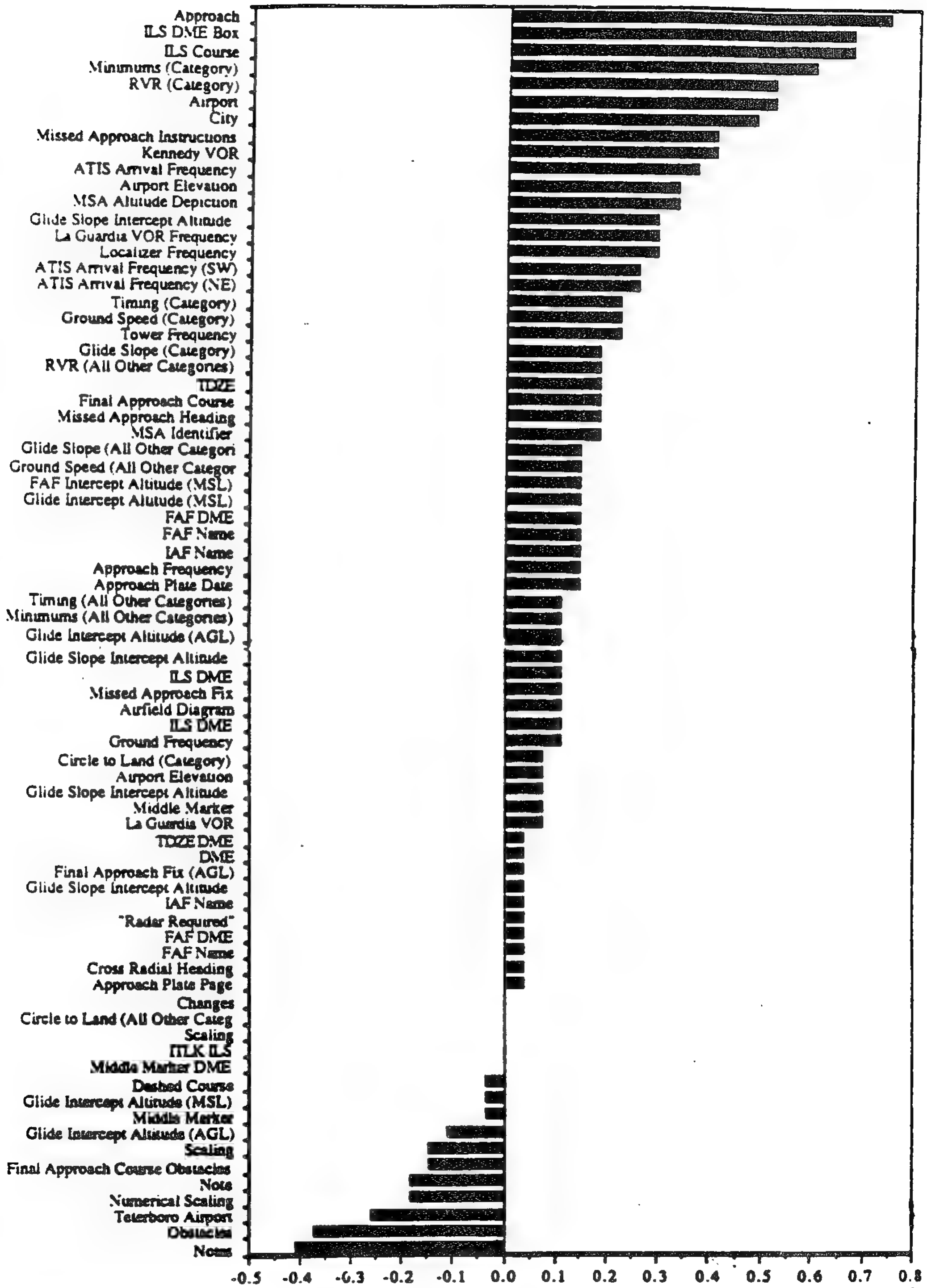

FIGURE 4-1. INFORMATION ELEMENT (ALL) RANKING

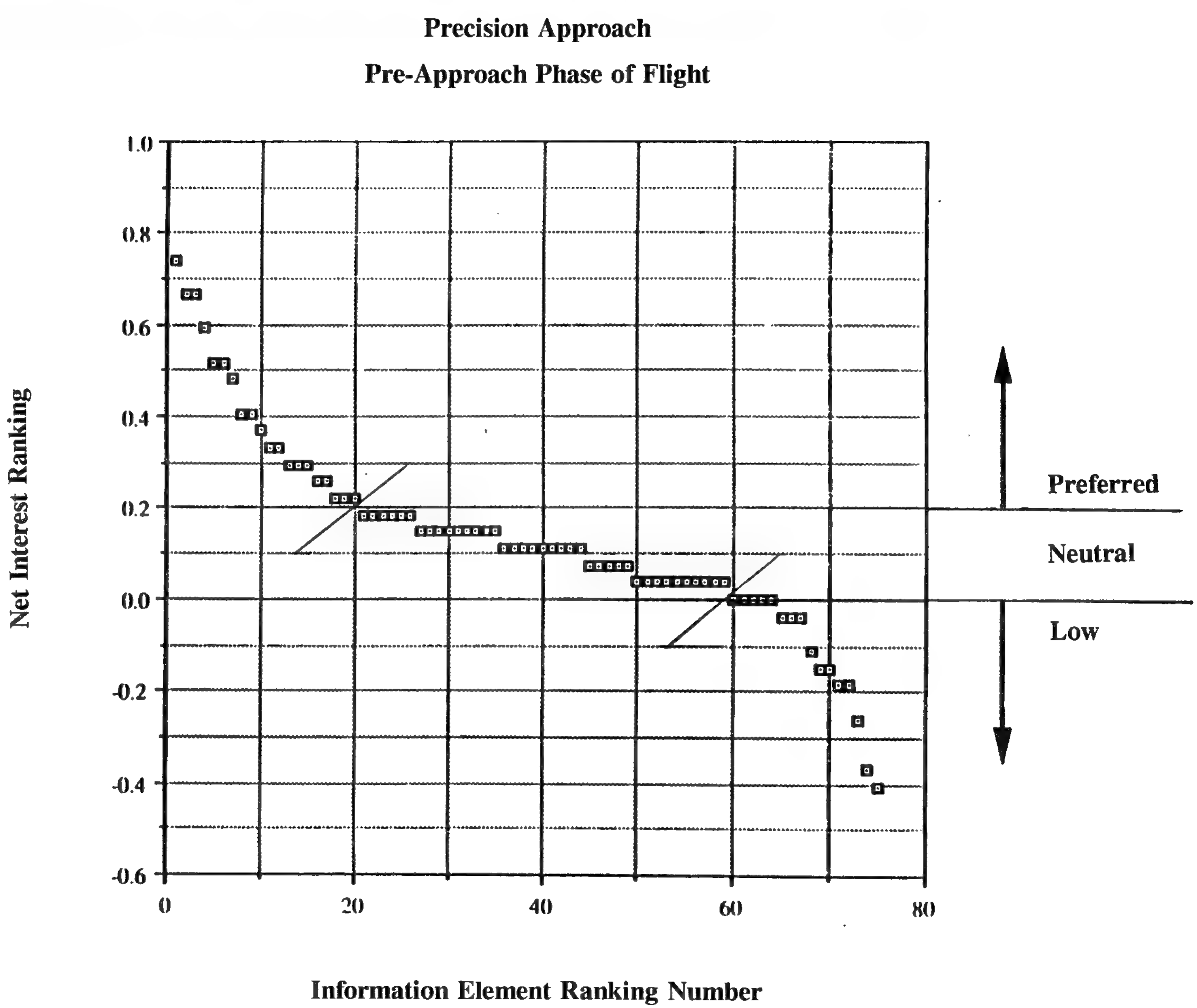

FIGURE 4.2 NET INTEREST RANKING CURVE

INFORMATION ELEMENT SELECTION
PRECISION APPROACH

"Preferred" Elements

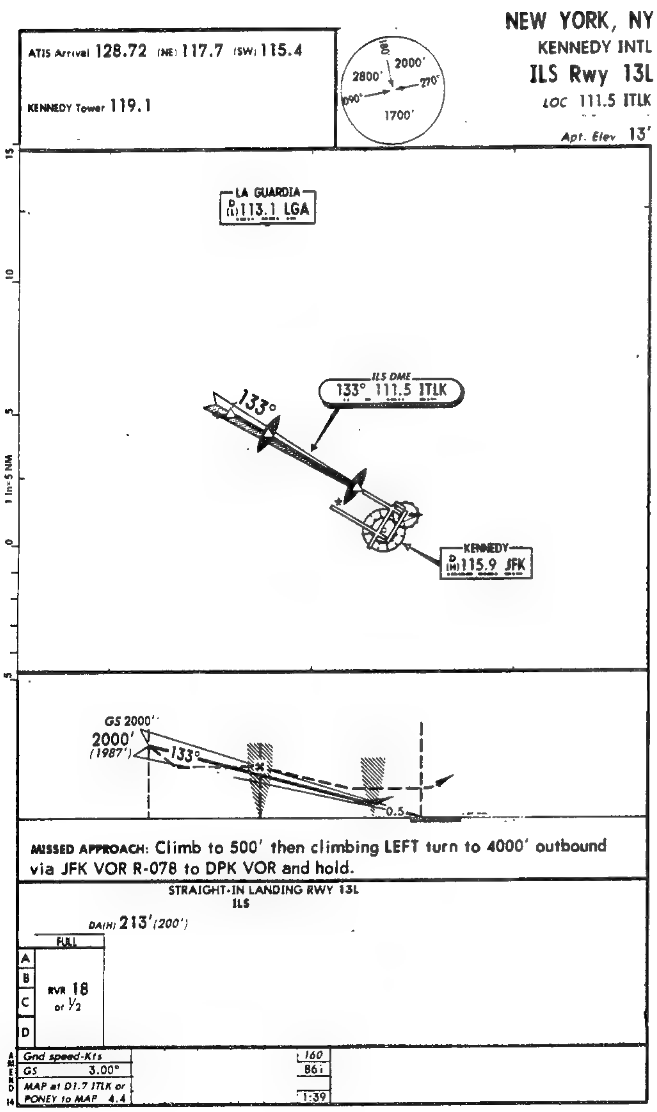

FIGURE 4-3A

"Preferred" and "Neutral" Elements

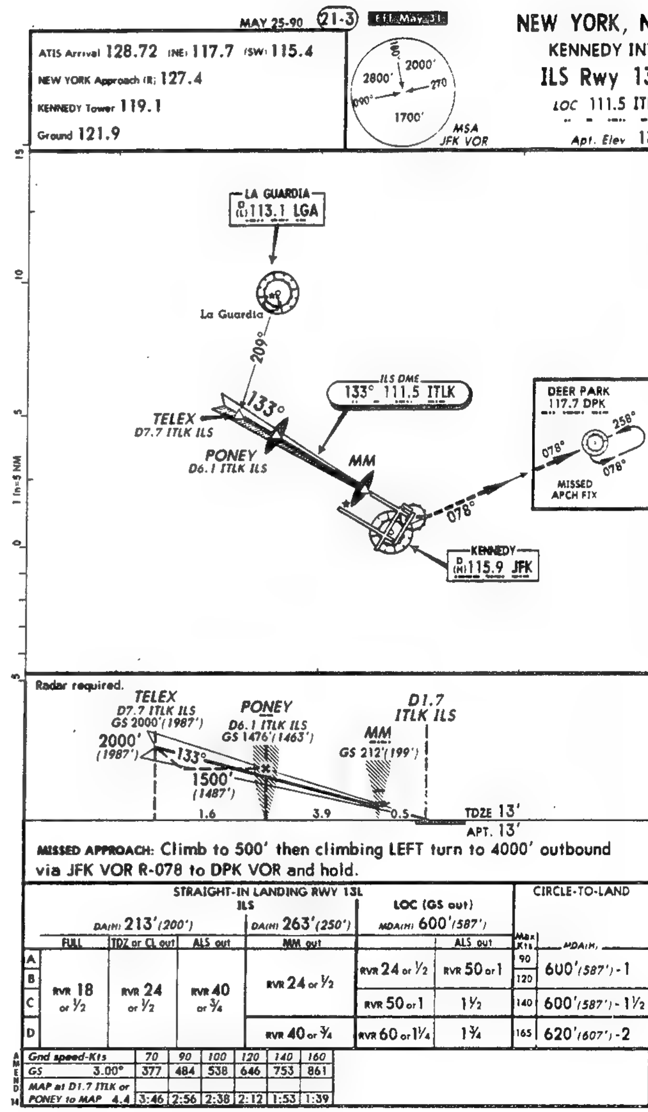

FIGURE 4-3B

generated using information elements from the precision approach, pre-approach phase of flight.

The large increase in the number of information elements in Figure 4-3b illustrates a dispersion of opinion concerning the amount of information required to execute a published instrument approach procedure. The IAP using only the preferred information elements (Figure 4-3a) illustrates a less dense interpretation of the information required to execute an instrument approach procedure. The IAP using both the preferred *and* neutral information elements (Figure 4-3b) from the same approach and phase of flight illustrates a more "conservative" approach toward information element selection. Note in Figure 4-3b that the combination of both information element categories constitutes a substantial increase in the amount of information that appears on the IAP.

In a similar manner, the concepts introduced above are illustrated using the preferred information elements from the non-precision IAP pre-approach phase of flight, (Figure 4-4a). The preferred *and* neutral information elements from the same approach and phase of flight are illustrated in Figure 4-4b.

In the remaining sections of this effort, *only the preferred* information elements per phase of flight for both the precision and non-precision IAP are considered. However, it is important to remember the degree of variability illustrated in Figures 4-3a and 4-3b, and Figures 4-4a and 4-4b, respectively.

4.3.3 Tracking the Flow of Information Elements: Precision Approach

The flow of preferred information elements from the precision IAP is presented and compared in this section. The same analysis for the non-precision approach is presented and compared in Section 4.3.4.

In order to track the flow of preferred information elements throughout each of the three phases of flight, the precision IAP format used in the survey was divided into four "Areas" that are depicted in Figure 4-5 and defined on page 32.

INFORMATION ELEMENT SELECTION
NON-PRECISION APPROACH

"Preferred" Elements

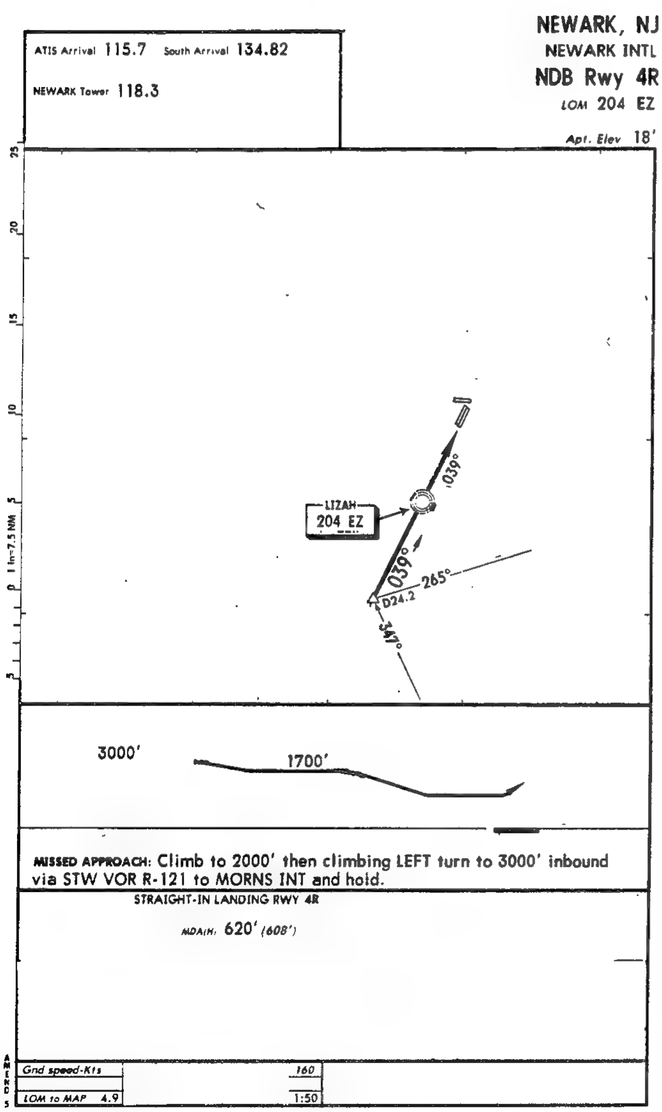

FIGURE 4-4A

"Preferred" and "Neutral" Elements

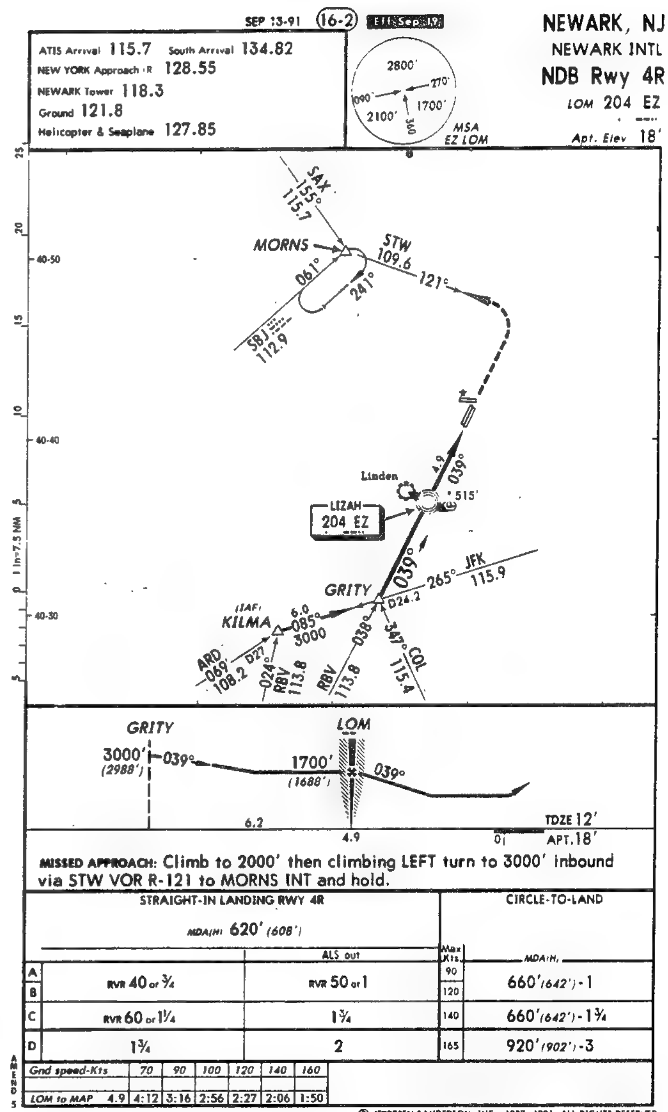

FIGURE 4-4B

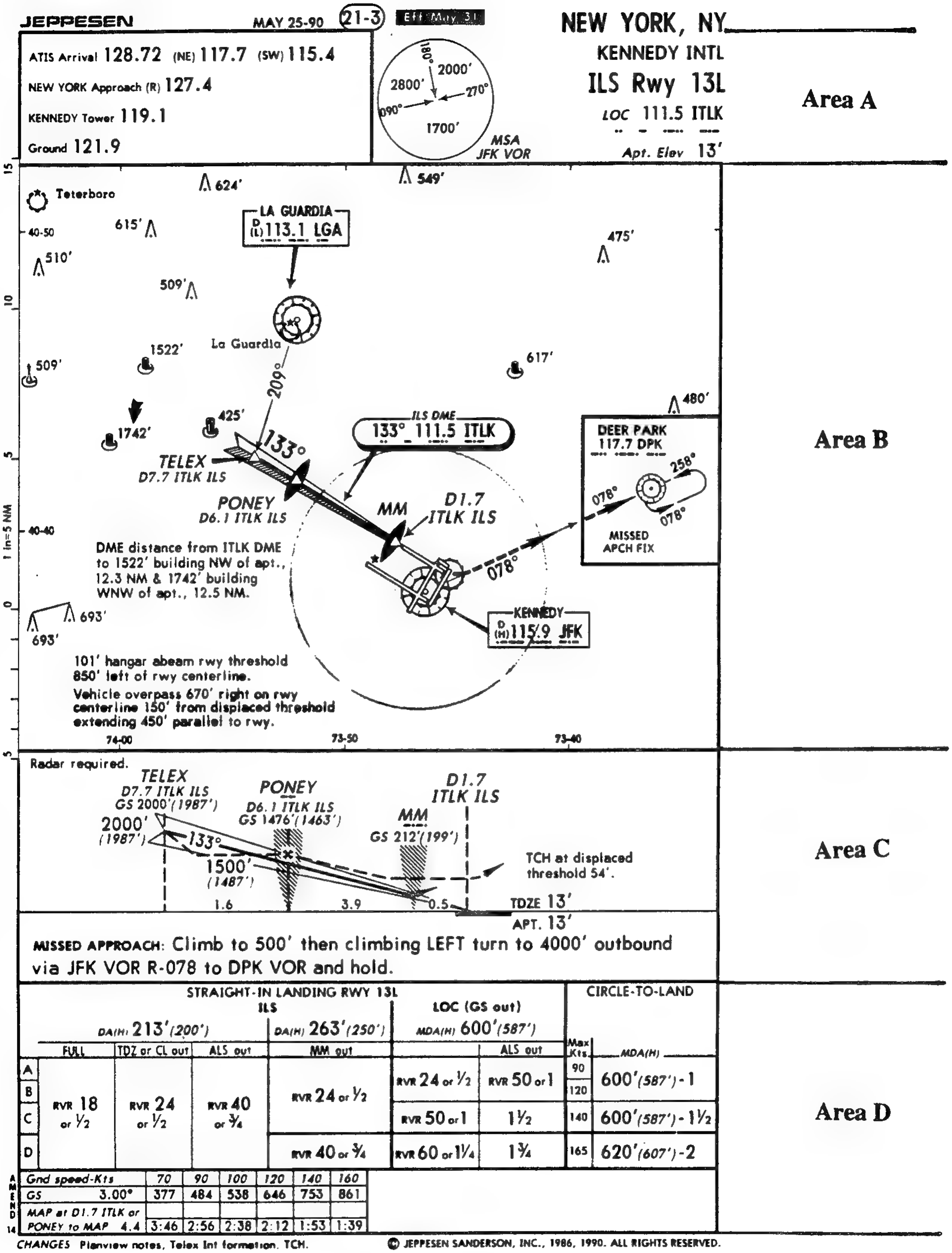

FIGURE 4-5. AREA COMPOSITION OF AN IAP

IAP Area A: Radio Communication Frequencies and Identification Information

This Area of the IAP is composed of radio communication frequencies, airport identification information, and depiction of the MSA.

IAP Area B: Plan-View Depiction of the Terminal Area

The central plan-view depiction of terminal area navigation information on the IAP.

IAP Area C: Profile Depiction of the Terminal Area

A "side" view depiction of the aircraft flight path. Missed approach instructions are also included in this section.

IAP Area D: Instrument Approach Procedure Minimums

The bottom section of the IAP that contains information concerning instrument approach procedure minimums that define the suitability of a particular approach to the prevailing weather conditions at the destination airport. In addition, aircraft "performance" categories (i.e., ground speed, approach procedure timing, and aircraft rates of descent) are included.

The flow of preferred information elements was tracked through each Area per phase of flight with a "flow-chart" (Figure 4-6) and sample IAP's that were generated (Figure 4-7) using the "preferred" information elements for each phase of flight. The total number of preferred information elements for each phase of flight is provided as a reference. Findings of this effort are described below.

4.3.3.1 IAP Area A: Communication Frequencies and Airport Identification Information

Respondents preferred to see a total of 20 information elements for the pre-approach phase of flight.

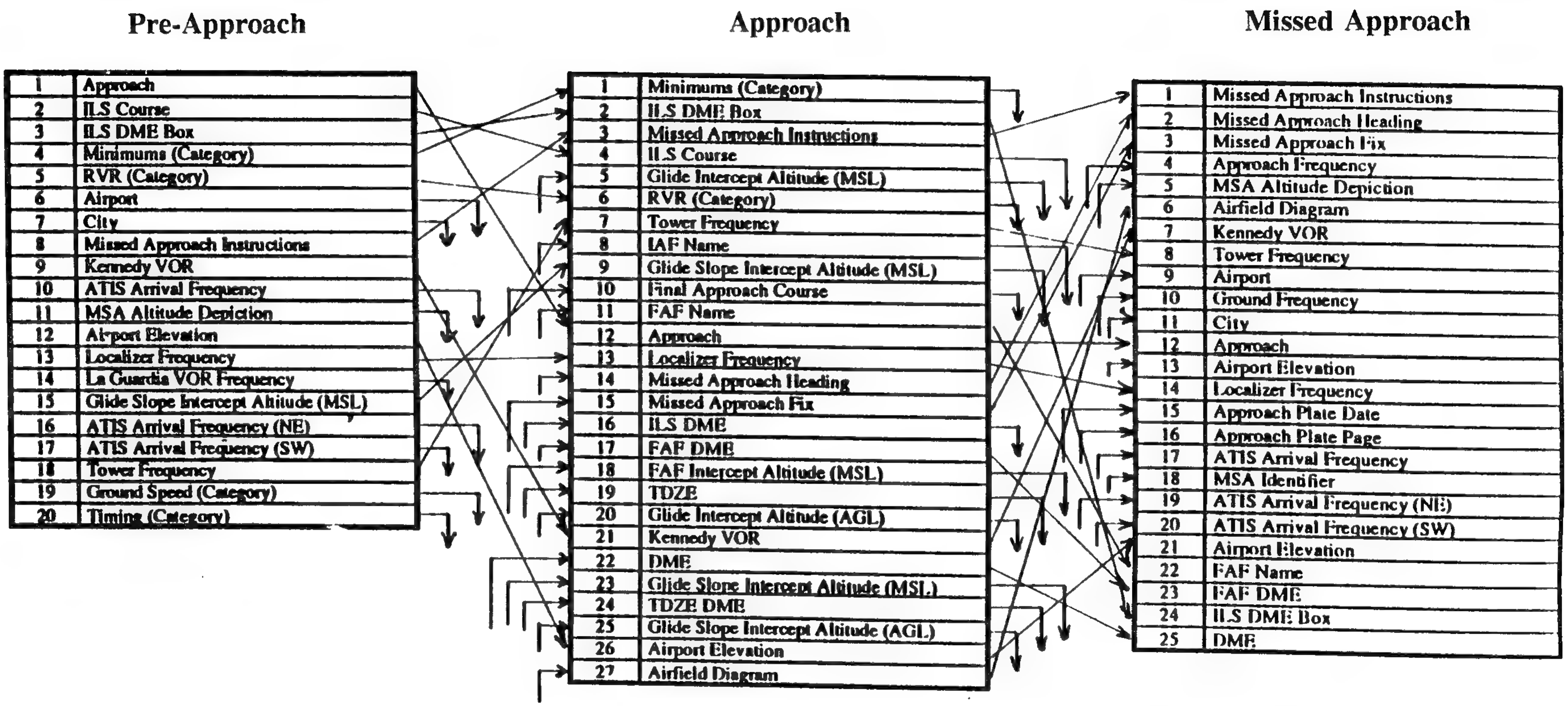

FIGURE 4-6. INFORMATION ELEMENTS FLOW CHART – PRECISION APPROACH

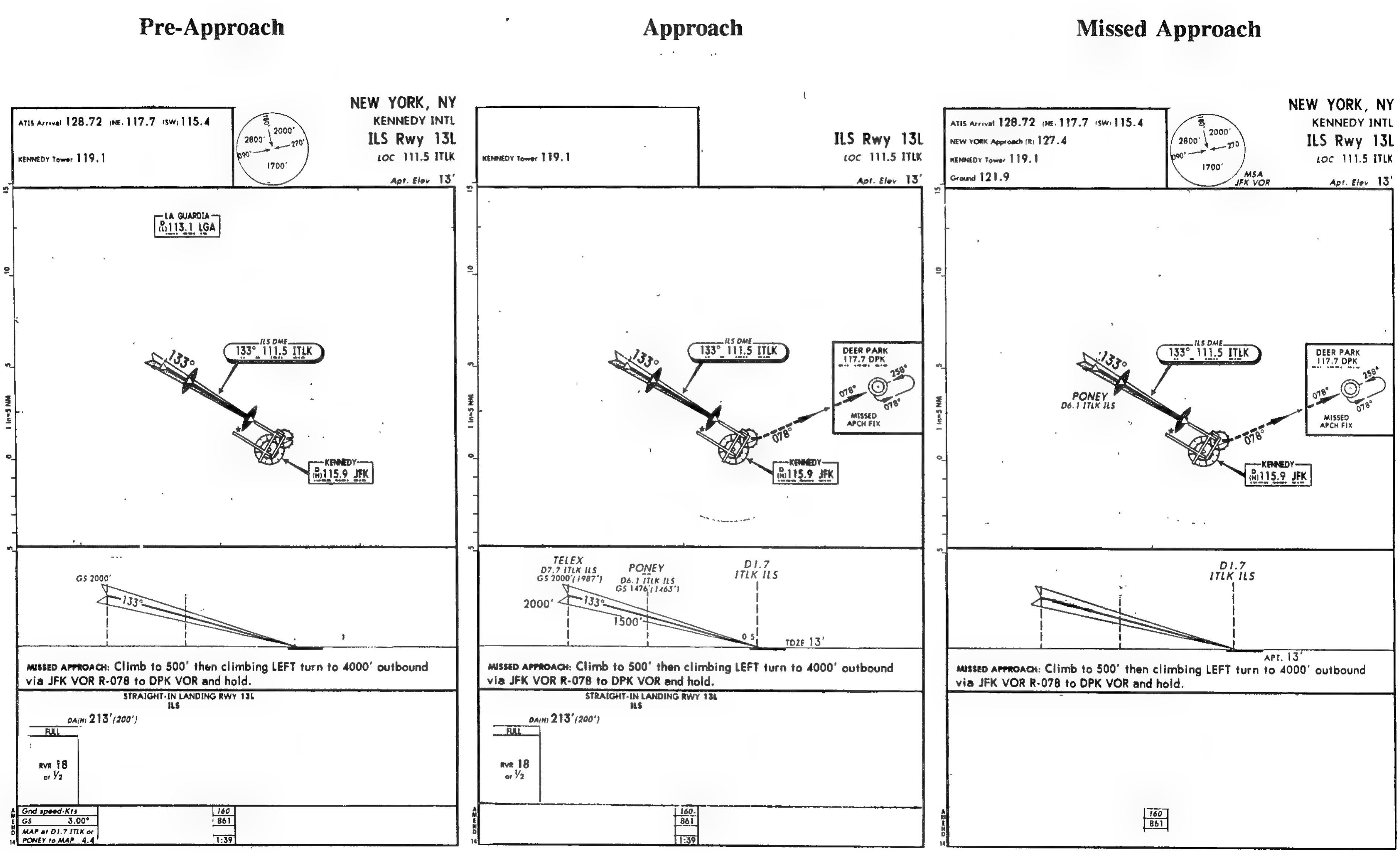

FIGURE 4-7. PREFERRED INFORMATION ELEMENTS PER PHASE OF FLIGHT — PRECISION APPROACH

Pre-Approach Phase

Respondents preferred to see all five airport identification information elements that are depicted in Area A. This may indicate a need for pilots to ensure they possess the correct information about the airfield prior to terminal area entry. Identification of the instrument approach procedure (Approach) received the highest Net Interest Ranking of all (20) preferred elements. No currency of information (Approach Plate Date) was preferred. Pilots preferred to see the Minimum Safe Altitude; it was ranked #11 of 20.

Approach Phase

Respondents preferred to see a total of 27 information elements for the approach phase of flight.

Of the 27 preferred information elements in this phase, identification of the instrument approach procedure (Approach), dropped in relative importance from #1 of 20 to #12 of 27. Respondents desired to see substantially less information from Area A; only four elements (31%) from Area A were chosen. The highest Net Interest Ranking attained by any of these four (Tower Frequency) was ranked #7 of 27. No terrain information was preferred.

Missed Approach Phase

Respondents preferred to see a total of 25 information elements for the missed approach phase of flight.

In this phase, the MSA was once again preferred; its ranking increased from the pre-approach phase (#11 of 20) to #5 of 25 in this phase. Overall, information requirements from Area A substantially increased as pilots preferred to see all information elements contained in Area A. Of the top 11 (overall), five of the preferred information elements were selected from this Area.

Based on this need for additional communication information, pilots may be preparing for the execution of a non-standard missed approach procedure. According to some of those interviewed, execution of non-standard missed approach procedures is a common occurrence. One pilot indicated that in twenty-four years of flying experience, he had "never flown the published missed approach procedure."

Phase of Flight Comparison: IAP Area A

The information requirements from this Area changed from phase to phase; the quantity and relative importance of preferred communication and identification information was substantially less for the approach phase of flight than it was for either the pre-approach or missed approach phases of flight.

Respondents expressed concern over radio communication frequencies. Either one of (or both) tower and approach frequencies ranked in the top half of all preferred elements throughout each phase. For the missed approach phase of flight where pilots may be preparing for the execution of a non-standard missed approach procedure, both frequencies were ranked within the top 40% of all preferred elements.

MSA depiction was preferred both for the pre-approach and the missed approach phases of flight. The increased Net Interest Ranking of this information element in the missed approach phase may indicate concern for hazardous terrain during the execution of a non-standard missed approach procedure.

4.3.3.2 IAP Area B: Plan-View Depiction of the Terminal Area

Pre-Approach Phase

Respondents preferred to see a total of 20 information elements for the pre-approach phase of flight.

Respondents were interested in approach course identification information. The ILS course was selected as the third most important of all 20 preferred elements in this phase of flight. Of the four preferred elements selected from this Area, three elements ranked in the top 5% overall; two elements (ILS course, and ILS Identification) were ranked #2 and #3 (overall), respectively. This high Net Interest Ranking may indicate that pilots are concerned with accurately identifying the approach procedure prior to terminal area entry. None of the terrain information depicted in Area B was preferred.

Approach Phase

Respondents preferred to see a total of 27 information elements for the approach phase of flight.

All elements from this Area that were selected for the pre-approach phase were once again selected for this phase; however, the relative importance of each changed. The ILS Course decreased in ranking from (#2 of 20) to #4 of 27, while the ILS Identification increased in ranking from (#3 of 20) to #2 of 27.

Additional information required for this phase of flight included the missed approach heading and the missed approach fix; they were ranked (#14 of 27) and (#15 of 27) of all preferred elements. The addition of this information may indicate that pilots are anticipating the execution of a missed approach procedure. Once again, none of the terrain information depicted in Area B was desired.

Missed Approach Phase

Respondents preferred to see a total of 25 information elements for the missed approach phase of flight.

In this phase, the missed approach heading and the missed approach fix increased in Net Interest Ranking; the missed approach heading increased from #14 of 27 to #2 of 25, and the

missed approach fix increased from #15 of 27 to #3 of 25. The FAF identifier (PONEY) was the only additional preferred information element selected; however, it ranked in the bottom 12% overall (22 of 25). None of the terrain information depicted in Area B was preferred.

Phase of Flight Comparison: IAP Area B

Information element preferences remained relatively constant throughout each phase of flight. The primary NAVAID was ranked in the top 10% of all preferred information elements for both the pre-approach and approach phases of flight.

4.3.3.3 IAP Area C: Profile Depiction of the Terminal Area

Pre-Approach Phase*

Respondents preferred to see a total of 20 information elements for the pre-approach phase of flight.

One (of several) information element (ILS Course [133°]) depicted on the actual IAP in Area B is also depicted on the actual IAP in Area C. Respondents preferred the depiction of that information element (#2 of 20) as it appears in Area B, but did not prefer it from Area C.

Approach Phase

Respondents preferred to see a total of 27 information elements for the approach phase of flight.

The quantity of preferred information desired in the approach phase increased dramatically from the pre-approach phase. Pilots preferred to see both the initial approach fix (IAF; TELEX), and the final approach fix (FAF; PONEY) as they are depicted in Area C of the

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* Note: Graphical depiction of the ILS Glide Slope symbol i.e., "the Arrow" is depicted in Figure 4-7 for each phase of flight as a reference.

actual IAP; overall, they were ranked #8 of 27, and #11 of 27, respectively. Both TELEX and PONEY are also depicted in Area B of the actual IAP; however, of all (27) preferred elements, neither was desired. MSL and AGL altitudes are depicted on the actual IAP for both the IAF and the FAF; however, respondents preferred to see only the MSL altitudes. The MSL altitude at TELEX was ranked #9 of 27, and the MSL altitude at PONEY was ranked #18 of 27. In this phase, the ILS Course (133°) was preferred from both Area B and Area C.

As it is depicted in Area B, pilots ranked this element #4 of 27; as it is depicted in Area C, it was ranked #10 of 27. The missed approach heading and the missed approach fix were preferred as pilots anticipate the possibility of a missed approach; the missed approach heading was ranked #14 of 27, while the missed approach fix attained a Net Interest Ranking of #15 of 27.

Missed Approach Phase

Respondents preferred to see a total of 25 information elements for the missed approach phase of flight.

The drastic reduction in the amount of information requested from the approach phase indicates a clear separation between these phases of flight. Only two elements, (D1.7ITLK; ILS DME, and Missed Approach Instructions) were preferred. Overall, they were ranked #1 of 25, and #25 of 25, respectively. The Missed Approach Instructions received the highest Net Interest Ranking.

Phase of Flight Comparison: IAP Area C

Pilots preferred to see the most information from this Area in the approach phase of flight. This additional, preferred information, may indicate that the profile view provides the pilot with the primary vertical navigation and guidance information during the approach phase of flight.

4.3.3.4 IAP Area D: Instrument Approach Procedure Minimums

Pre-Approach Phase

Respondents preferred to see a total of 20 information elements for the pre-approach phase of flight.

There are 19 sets of procedure minimums depicted on the actual IAP in Area D. In the survey, these procedure minimums were grouped into two general categories; pilot preferences for procedure minimums were recorded as they applied to either their "own" category** aircraft, and/or to all other aircraft categories. Respondents preferred to see procedure minimums that apply only to their own category** aircraft. Overall, procedure minimums attained a Net Interest Ranking of #4 of 20.

There are 18 individual aircraft performance characteristics depicted on the IAP; aircraft speed over the ground (Ground Speed), timing, and rates of descent. In the survey, these aircraft performance characteristics were grouped into two general categories; pilot preferences for aircraft performance categories were recorded as they applied to either their own category aircraft, and/or to all other aircraft categories.

Once again, respondents preferred to see performance characteristics that only apply to their own category aircraft. Ground Speed received a Net Interest Ranking of #19 of 20, while timing was ranked #20 of 20.

Information element selection (and Net Interest Ranking) for the pre-approach phase may indicate that it is important for the pilot to know the procedure minimums that apply only to the pilot's own category aircraft prior to terminal area entry. The Net Interest Rankings for timing and ground speed may indicate that these information elements are more advisory than imperative for the pre-approach phase of flight.

** Aircraft categories (A,B,C,D) are based on aircraft weight and airspeed. Procedure minimums are depicted for each category aircraft.

Approach Phase

Respondents preferred to see a total of 27 information elements for the approach phase of flight.

In this phase, respondents indicated that their own category minimums received an overall Net Interest Ranking of #1 of 20.

Missed Approach Phase

Respondents preferred to see a total 25 information elements for the missed approach phase of flight.

No information was preferred for the missed approach as the pilot transitions to a safer (higher) altitude.

Phase of Flight Comparison: IAP Area D

In all phases of flight, pilots preferred to see only category specific information.

4.3.4 Tracking the Flow of Information Elements: Non-Precision Approach

The flow of preferred information elements from the non-precision approach is presented in this section. The information requirements for both IAP formats (precision and non-precision) are compared in Section 4.3.5.

Following the procedure outlined in Section 4.3.3, the non-precision IAP used in the survey was divided into four Areas that are depicted in Figure 4-6. The flow of information was tracked with a flow-chart (Figure 4-8) and sample IAP's that were generated (Figure 4-9) using the preferred information elements for each phase of flight. Preferred information elements for each Area were tracked through each phase of flight and then compared. The

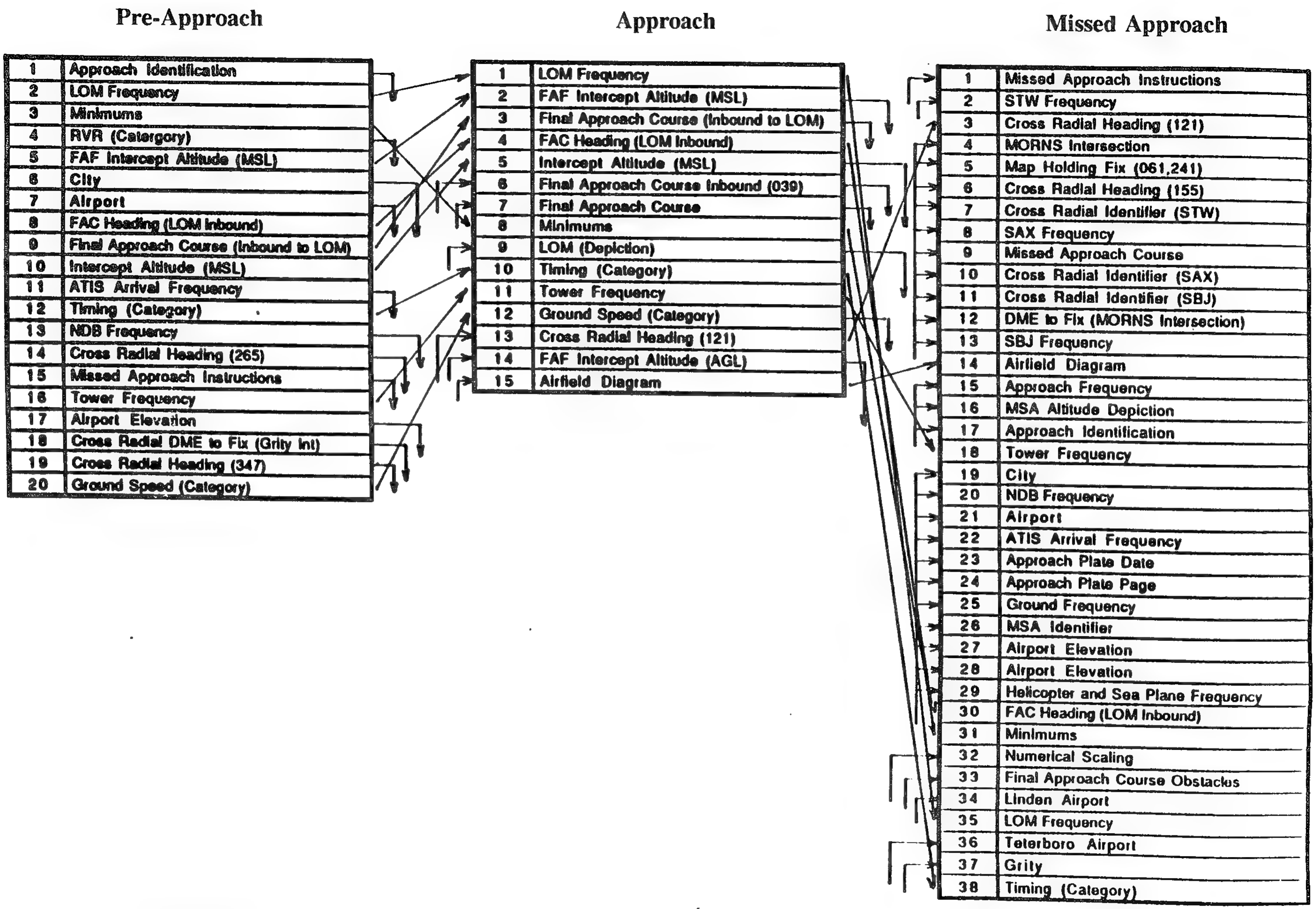


FIGURE 4-8. INFORMATION ELEMENTS FLOW CHART – NON-PRECISION APPROACH

Pre-Approach | Approach | Missed Approach

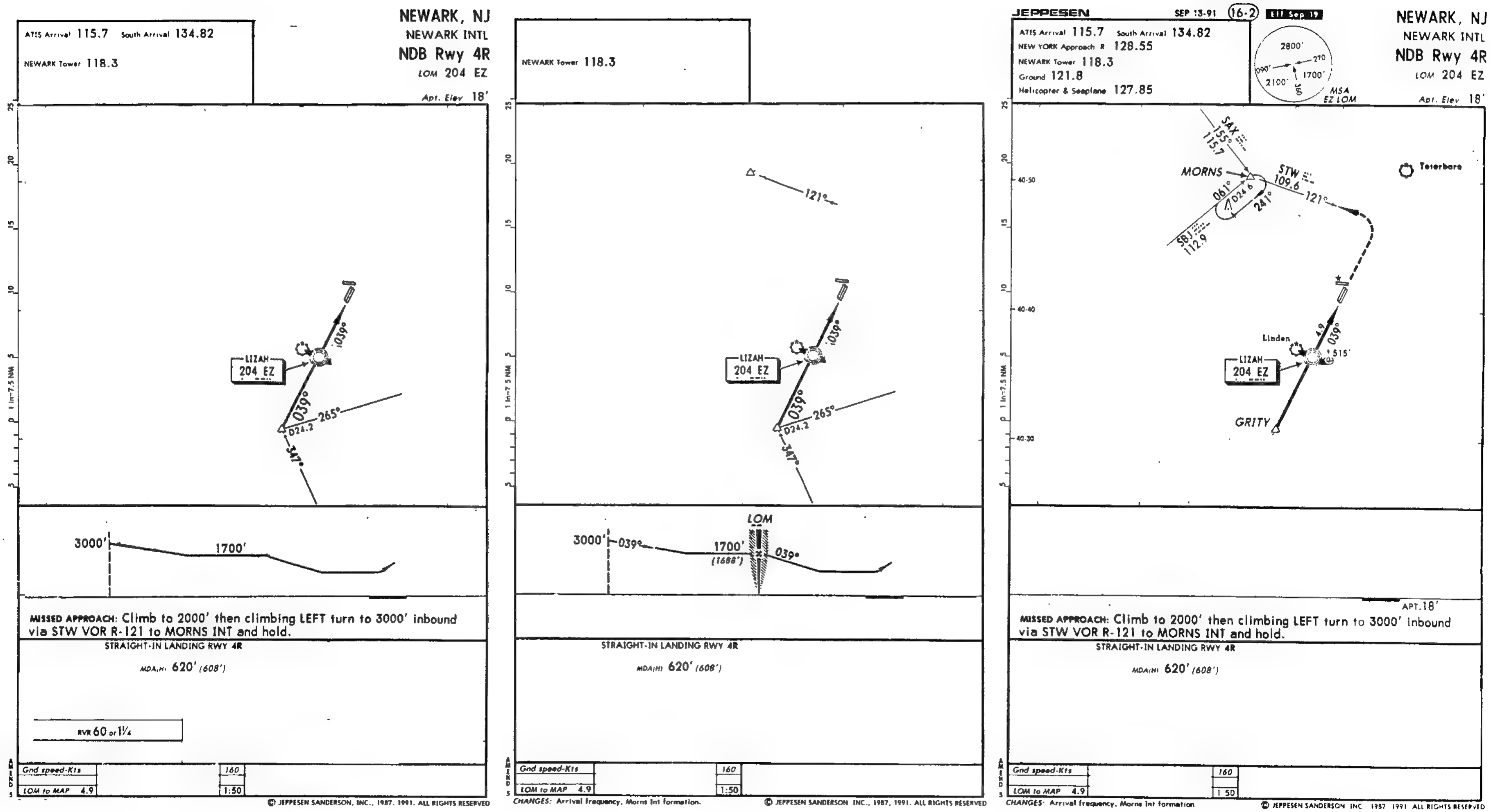


FIGURE 4-9. PREFERRED INFORMATION ELEMENTS PER PHASE OF FLIGHT – NON-PRECISON APPROACH

total number of preferred information elements for each phase of flight are provided as a reference. Findings of this effort are described below.

4.3.4.1 IAP Area A: Communication Frequencies and Airport Identification Information

Pre-Approach Phase

Respondents preferred to see a total 20 information elements for the pre-approach phase of flight.

Respondents preferred to see all five airport identification information elements that are depicted in Area A. This may indicate a need for pilots to ensure that they possess the correct airfield information prior to terminal area entry. Identification of the instrument approach procedure (NDB Rwy 4R) was ranked #1 of 20 in Net Interest Ranking for the pre-approach phase of flight. No currency of information (approach plate date) was preferred.

Approach Phase

Respondents preferred to see a total of 15 information elements for the approach phase of flight.

Only one information element (Tower Frequency) was preferred from Area A. This element was ranked #11 of 15 in Net Interest Ranking for this phase of flight.

Missed Approach Phase

Respondents preferred to see a total of 38 information elements for the missed approach phase of flight.

A clear separation between the approach and missed approach phases of flight is indicated by the increase in the number of preferred information elements. From the approach phase, respondents preferred to see only one information element; however, they preferred all information elements depicted in Area A for the missed approach phase of flight. Based on this need for additional communication information, pilots may be preparing for the execution of a non-standard missed approach procedure.

Phase of Flight Comparison: IAP Area A

The quantity of information preferred from Area A was the greatest during the missed approach phase of flight; however, all of the information elements that attained the highest Net Interest Ranking occurred during the pre-approach phase of flight. They were: Identification of the instrument approach procedure (NDB Rwy 4R), #1 of 20, "City," #6 of 20, and airport, #7 of 20.

4.3.4.2 IAP Area B: Plan-View Depiction of the Terminal Area

Pre-Approach Phase

Respondents preferred to see a total 20 information elements for the pre-approach phase of flight.

The primary NAVAID (LIZAH), was ranked #2 in Net Interest Ranking of all 20 preferred information elements for this IAP. The Final Approach Course (039°), was ranked #3 of 20.

Approach Phase

Respondents preferred to see a total of 15 information elements for the approach phase of flight.

The quantity of information preferred from Area B for the approach phase remained almost unchanged from the pre-approach phase; however, the primary NAVAID (LIZAH) increased in Net Interest Ranking from #2 of 20 to #1 of 15.

Missed Approach Phase

Respondents preferred to see a total of 38 information elements for the missed approach phase of flight.

Several additional information elements were preferred from Area B for the missed approach phase. The most notable addition was "Final Approach Course Obstacles"; however, this information element received a Net Interest Ranking of #33 of 38 (Bottom 13%) of all preferred information elements for this phase of flight.

Phase of Flight Comparison: IAP Area B

The quantity of information required from Area B remained relatively constant for both the pre-approach and approach phases. The primary NAVAID was ranked in the top 10% of all elements for both phases of flight. Terrain information presented in Area B was only preferred for the missed approach phase of flight.

4.3.4.3 IAP Area C: Profile Depiction of the Terminal Area

Pre-Approach Phase

Respondents preferred to see a total of 20 information elements for the pre-approach phase of flight.

Pilots preferred to see only four information elements from Area C for this phase of flight. Both AGL and MSL altitudes are presented at GRITY and at the Compass Locator at the Outer Marker (LOM); however, in both instances, pilots preferred to see only the MSL altitude.

Approach Phase

Respondents preferred to see a total of 15 information elements for the approach phase of flight.

The preferred information elements for the pre-approach phase of flight were also preferred for the approach phase of flight; however, the (LOM), FAC, and FAF intercept altitude were added. The FAF attained a Net Interest Ranking of #2 of 15. The FAC (039°) is presented in both Area B and in Area C; pilots preferred to see both. However, the FAC from Area B was ranked #3 of 15, while the FAC from Area C was ranked #7 of 15. Missed approach instructions were not preferred in this phase.

Missed Approach Phase

Respondents preferred to see a total of 38 information elements for the missed approach phase of flight.

The missed approach instructions received a Net Interest Ranking of #1 of 38. No other elements from this Area were preferred for the missed approach phase of flight.

4.3.4.4 IAP Area D: Instrument Approach Procedure Minimums

Pre-Approach Phase

Respondents preferred to see only their own category procedure and performance minimums.

Approach Phase

Respondents preferred to see only their own category procedure and performance minimums.

Missed Approach Phase

Respondents preferred to see only their own category procedure minimums.

Phase of Flight Comparison: IAP Area D

For each phase of flight, respondents preferred to see only their own category procedure and performance minimums. Procedure minimums attained the highest Net Interest Ranking (#3 of 20) in the pre-approach phase. Procedure minimums received the lowest Net Interest Ranking in the missed approach phase of flight (#31 of 38).

4.3.5 Comparison of Information Requirements: Precision vs. Non-Precision Approach

Table 4-8 summarizes and compares pilot information requirements (total number of information elements) per phase of flight for both the precision and non-precision approaches for the general respondent group.

TABLE 4-8. COMPARISON OF INFORMATION REQUIREMENTS: PRECISION VS. NON-PRECISION APPROACH

Type of Approach	Phase of Flight	Total Respondent Group		
		Preferred	Neutral	Both
Precision Approach	I. Pre-Approach	20	39	59
	II. Approach	27	35	62
	III. Missed Approach	25	31	56
Non-Precision Approach	I. Pre-Approach	20	56	76
	II. Approach	15	37	52
	III. Missed Approach	38	41	79

A review of the information requirements for both the precision and non-precision approach resulted in the following observations:

1. The depiction of terrain information was not a priority. Pilots preferred terrain information in only 1 of 6 phases of flight; however, in that particular phase of flight (non-precision IAP, missed approach phase), it received a Net Interest Ranking in the bottom 12% (#33 of 38) of all preferred information elements.

   Depiction of the MSA was preferred for the pre-approach and missed approach phases of flight for the precision IAP; it was preferred for the missed approach phase of flight for the non-precision IAP. This may indicate that, while pilots may prefer to have terrain information depicted, they do not agree with how it is currently depicted on the IAP.

2. A substantial amount of additional information elements was preferred for the missed approach phase of flight for the non-precision IAP than for the missed approach phase of flight for the precision IAP. This increase in information elements may indicate that the navigational fixes on the non-precision IAP are greater in number and are more complex (they require more information to describe them) than the navigational fixes depicted on the precision IAP.

3. A substantial amount of additional information elements was preferred for the approach phase of flight for the precision IAP than for the approach phase of flight of the non-precision IAP. Since approach minimums are lower (closer to the ground) for a precision approach than for a non-precision approach, the profile view (Area C) of the precision IAP depicts (in greater detail) a more complex procedure than is depicted in Area C on the non-precision IAP. (Area C on the actual precision IAP contains 24 information elements; Area C on the actual non-precision IAP contains 11 information elements).

   Of the 27 preferred information elements for the precision IAP, 14 (of 24 actually depicted) came from Area C. The additional preferred information elements from Area

C for the precision IAP may indicate that the profile view provides the pilot with the primary vertical navigation and guidance information during the approach phase of flight for the precision IAP.

Although the approach procedure (as depicted in Area C) is not as complex for the non-precision IAP, of the total number of preferred information elements (15) for the non-precision IAP, 5 (of 11 actually depicted) came from Area C. This may indicate that the profile view also provides the pilot with the primary vertical navigation and guidance information during the approach phase of flight for the non-precision IAP.

4. Differences in information requirements indicate a clear separation between the approach and missed approach phases of flight for each respective IAP. For the precision IAP, pilots preferred a total of 52 information elements from the approach and missed approach phases of flight. Only seven information elements (13.5%) were common to both. For the non-precision IAP, pilots preferred a total of 53 information elements from the approach and missed approach phases of flight. Only four information elements (7.5%) were common to both.

5. Of all preferred intercept altitudes from the profile view of both IAP's, five of seven (71.5%) were MSL altitudes.

6. Survey respondents indicated that the top 30% of all preferred information elements are virtually identical for the pre-approach phase of flight for the precision and non-precision for both IAP's. Information elements common to both include: identification of the approach procedure, the final approach course, their own category procedure minimums, identification of the primary NAVAID, city, and the destination airport.

4.3.6 Comparison of Information Requirements ("Glass-Cockpit" Subgroup vs. General Respondent Group)

It was desired to compare the information requirements of the subgroup comprised of pilots who have accumulated flight experience in advanced automated, glass-cockpit aircraft, with the information requirements of the general respondent pilot group.

Following the procedure that was described in Section 4.3.2, Net Interest Ranking curves (Appendix J) were generated in order to identify critical information elements per phase of flight for the glass-cockpit pilot subgroup. Table 4-9 compares the information requirements from the general respondent group to the information requirements of the glass-cockpit subgroup.

TABLE 4-9. TABLE OF COMPARISON: "GLASS-COCKPIT" SUBGROUP VS. GENERAL RESPONDENT GROUP

Type of Approach	Phase of Flight	Total Respondent Group			Pilots with "Glass Cockpit" Flight Experience		
		Preferred	Neutral	Both	Preferred	Neutral	Both
Precision Approach	I. Pre-Approach	20	39	59	29	35	64
	II. Approach	27	35	62	23	32	55
	III. Missed Approach	25	31	56	25	32	57
Non-Precision Approach	I. Pre-Approach	20	56	76	31	29	60
	II. Approach	15	37	52	26	22	48
	III. Missed Approach	38	41	79	15	42	57

The quantity and content of the preferred information elements of the glass-cockpit subgroup were compared to those of the general respondent group. No substantial differences exist between the information preferences for each respective group.

4.4 SURVEY SECTION IV: (ELECTRONIC INSTRUMENT APPROACH PLATES)

Due to limitations in display technology, electronic replication of paper approach plates may limit the amount of approach information available to the pilot at any particular point in the execution of a published instrument approach procedure. However, electronic approach plates may also provide the pilot with the flexibility to select only that approach information that the pilot desires to see.

4.4.1 Preferences for Electronic Charts

This section of the survey was included in order to determine whether pilots would be receptive to the use of a new form of electronic cockpit instrumentation. In addition, respondents were asked to comment on the use of electronic IAP's without a paper IAP backup.

While over 70% of the general respondent group favored electronic replication of paper IAP's, user comments were wide and varied concerning system reliability:

> *"... I don't feel that electronic technology precludes the need for paper back up... What if the system dies on final? It depends on system reliability; I've seen the computer make too many mistakes to rely on it solely..."*

Responses to the questions asked in this section are presented in Table 4-10.

TABLE 4-10. PREFERENCES FOR ELECTRONIC CHARTS	
Electronic Replication of Paper IAP's	72.4% Yes
Use of Electronic IAP Without Backup	31.0% Yes
Prefer Static Electronic IAP	27.50%
Prefer Dynamic Electronic IAP	72.50%

In order to determine the most effective means by which to present electronic IAP information, respondents were asked to indicate their preferences regarding two electronic IAP prototype designs: static and dynamic. The static plate is a replication of the paper chart with a north-up orientation, while the dynamic chart has a moving map plan-view presentation (similar to the Electronic Horizontal Situation Indicator [EHSI]) and a track-up orientation.

The vast majority of respondents (72.5%) indicated that they would prefer to see electronic IAP information presented dynamically; all respondents with glass-cockpit experience indicated a preference for the dynamic IAP. Those respondents who preferred the static IAP selected it due to a "familiarity with the north up orientation" contained on current paper IAP formats.

4.4.2 Customizing of the IAP

Customizing an IAP offers the opportunity for more flexibility in the presentation of approach information; pilots can select or deselect approach information in order to reduce chart clutter (Table 4-11).

While most respondents (69%) expressed an interest in customizing their IAP's, they remained somewhat skeptical about the suppression of information. This skepticism stemmed from the "worst case scenario; terminal area operations, adverse weather conditions, and the need for approach information that has been suppressed but is not retrievable. Some presented alternatives:

> *"...A problem could present itself if pilots suppressed too much information on a routine basis automatically. I would feel comfortable because I would not suppress too much information..."*

TABLE 4-11. CUSTOMIZING THE IAP	
Desire to Customize Own IAP	69.0% Yes
Workload Increase if Customize Plate	31.0% Yes
Display of Info: Autoflight vs.Manual	86.2% Yes
Moving Map Display For Ground Ops.	72.4% Yes

Some respondents expressed concern that customizing their IAP would require too much "head down" time in the terminal area programming the computer; however, nearly 70% of the respondents indicated that this would not impose any additional workload demands on the flight crew. Respondents were especially receptive to customizing the IAP if it could be accomplished *prior* to departure.

5. CONCLUSIONS

This report documents a user-centered survey and interview effort conducted to analyze the information content of current Instrument Approach Plates (IAPs). The analysis included data from a pilot opinion survey of approach chart information requirements. It is important to note that the survey attained a low response rate (9.7%) that is thought to be attributed to the extensive nature of the survey, which required approximately 1.5 hours to complete. Therefore, the respondents are self-selected, and represent a defined pilot subgroup whose data may not be fully representative of the general user group.

Both precision and non-precision IAP formats were examined. Respondents indicated their preferences for approach information and when (at what point during the execution of the approach procedure) they preferred to see this information.

In addition to the survey, focused interviews were conducted with pilots who represent the full spectrum of operational IAP user communities from major domestic air carriers to general aviation. These investigations resulted in the following findings.

1. A substantial number (93%) of pilots felt that it was possible to make operational errors in the cockpit that can be attributed to charting considerations; however, a majority (59%) indicated that a major change in IAP format is neither warranted nor desired.

2. Differences in instrument approach information requirements indicate that preferences for this information change as the pilot progresses through various phases of flight during the execution of an instrument approach procedure.

3. Depiction of terrain information on the IAP is a low priority. A vast majority of survey respondents (80%) indicated that a reduction in the amount of terrain information depicted on current IAP formats is desired.

Pilots did, however, express a desire to have Minimum Safe Altitude (MSA) information available. This may indicate that pilots desire to have some form of terrain information depicted, but do not agree with the manner in which it is currently depicted on the IAP.

4. Pilot information requirements suggest that the profile view of the IAP provides the pilot with the primary vertical guidance and navigation information during the approach phase of flight of an instrument procedure for both precision and non-precision formats.

5. A vast majority of the respondent group (70%) were in favor of electronic replication of current IAP formats. However, respondents expressed concern about system reliability; only 31% indicated that they would be comfortable using an electronic IAP format without a paper IAP backup.

6. Information requirements of the general respondent group were compared to those of a subgroup comprised of pilots with experience in advanced automated, glass-cockpit aircraft. The quantity and content of the information most desired by both groups indicated that no substantial differences exist in their respective information requirements.

REFERENCES

1. Airman's Information Manual (AIM), Basic Flight Information and ATC Procedures, U.S. Department of Transportation; Federal Aviation Administration, Sept. 21, 1989, Washington, D.C.

2. Instrument Flying Handbook, U.S. Department of Transportation, Federal Aviation Administration (AC-61-27C).

3. United States Standard for Terminal Instrument Procedures (TERPS), Federal Aviation Administration Administration Handbook 8260.3B, 1976.

APPENDIX A

Survey of Approach Chart Information Requirements

SURVEY OF APPROACH CHART INFORMATION REQUIREMENTS

Purpose

The Department of Aeronautics and Astronautics at the Massachusetts Institute of Technology is currently evaluating the design and format of aeronautical charts. The focus of this survey is to evaluate the importance of instrument approach information available to the pilot, and to determine at what point during the approach procedure it is most desirable to have this information.

By investigating crew preferences related to Instrument Approach Plates (IAP), and surveying the information content of these plates, we hope to gain an understanding of pilot preferences concerning the categorization and prioritization of approach chart information as it pertains to phase of flight. This information will help us to determine what information should be contained on advanced electronic instrument approach plate designs.

Structure

This survey consists of four parts and will take approximately 30 minutes to complete. As an introduction to each individual section, a brief description and background is provided. Section I consists of questions concerning your aviation background. The second section asks you to describe your preferences concerning the utilization of the information currently contained on instrument approach plates. In the third section, you will be presented with sample precision and non-precision Jeppeson-Sanderson IAP's and asked to identify, per phase of flight, the approach information you feel is critical to complete that particular phase of flight. The final section seeks to determine your preferences regarding electronic instrument approach plates.

Please remember that this is only a survey of your opinions and that there are no "correct" answers to these questions. Your assistance in this survey is crucial to helping us prioritize the information of current IAP's.

All information provided will remain strictly confidential

The Survey Team

The individuals conducting this survey are experienced aviators well versed in instrument approach procedures. We are always available and interested in your opinions. <u>Please</u> feel free to call or contact us at any time if you have any questions regarding the survey or wish to discuss anything concerned with this project.

Faculty Representative:

Prof. R. John Hansman, Jr.
Aeronautical Systems Laboratory
MIT, Rm. 33-115
77 Massachusetts Ave.
Cambridge, MA. 02139
(617) 253-2271

Research Assistant:

Mark G. Mykityshyn
Aeronautical Systems Laboratory
MIT, Rm. 37-442
77 Massachusetts Ave.
Cambridge, MA. 02139
(617) 253-7748

I. BACKGROUND INFORMATION

A. Purpose

Information concerning your aviation background will help us to more accurately assess the variables that affect pilot preferences. *Remember, all information you provide will remain completely anonymous.*

B. Personal Data/Miscellaneous Information

1. Age: ______________ Sex: Male ( ) Female ( )

2. Highest Education Level:

   ( ) High School ( ) College ( ) College Degree ( ) Graduate Work/Degree

3. Highest math level

   Arithmetic — Beyond Calculus

   1 2 3 4 5

4. Do you have any experience on Flight Management Computer (FMC) equipped aircraft?

   Yes ( ) No ( )

5. Computer experience (other than FMC) as a user.

   No knowledge of software packages — Knowledge of several software packages

   1 2 3 4 5

6. How often do you use computers (hours per week) as a(n):

   Recreational User ( ) Operational User (Workplace only) ( )

   Do not use computers if I don't have to ( )

C. Aviation Experience

1. How were you *initially* trained to fly?

   Civil ( )   Military ( )

2. *Civil Experience*:

   A. Total civil pilot flight time: ____________

   B. Pilot ratings held:

      Fixed Wing: ATP ( )   Commercial Pilot ( )   F.E. Written ( )

      Rotary Wing: ATP ( )   Commercial Pilot ( )   Other____________

   C. Civil flight experience by aircraft type:

      Rotary Wing ( )   Fixed Wing ( )   ( ) Both

3. *Military Flight Experience*:

   A. Total military flight time: __________

   B. Military flight experience by aircraft type:

      Rotary Wing ( )   Fixed Wing: Tactical ( )   Transport ( )   Both ( )

   C. Do you currently fly in the military reserves?

      Yes ( )   No ( )

D. Transport Category Aircraft Flying Experience

1.

AIRCRAFT TYPE	FLIGHT HOURS (Approximate)	POSITION*
1		
2		
3		
4		
5		

*Captain, First Officer, Second Officer, Flight Instructor/Check Pilot

2. Estimated Flight Hours in 1989 __________

II. GENERAL IAP USAGE

A. Purpose

The purpose of this section of the survey is to help us evaluate the information content of the two most widely used domestic IAP's, Jeppeson-Sanderson Inc., and the U.S. Government (NOAA and the Department of Defense in conjunction with the FAA).

Please evaluate the information content of these IAP's with regard to factors that contribute to approach plate clutter; for example, terrain and obstruction information, and describe your preferences concerning the use of available instrument approach plate information.

B. Information Content

1. With which IAP have you had the most experience? If other, please specify.

( ) Jeppeson-Sanderson ( ) NOAA/DOD ( ) Other

---

2. Which IAP do you *currently* use the most often:

( ) Jeppeson-Sanderson ( ) NOAA/DOD ( ) Other

For questions 3-7, please answer based on the response given for question (1) above.

3. Aviators have stated that there can be both too much *and* too little information contained at the same time on an IAP. How do you feel about the quantity of information presented on IAP's? Please comment.

Not enough information				Too much information
1	2	3	4	5

---

4. Is the critical information, i.e., a localizer frequency, difficult to locate or interpret? Please comment.

Never		Occasionally		Always
1	2	3	4	5

____

____

____

____

____

*NOTE: For questions 5 and 6, assume that the terminal area is defined as the area within a 30NM radius of the airfield. You are the pilot "hand flying" the approach in IFR conditions under radar control.

5. What percentage of your time, *on average*, do you spend in the terminal area finding and selecting approach information from the IAP? Please circle one of the following and comment on your interpretation of how much time comprises the two categories provided.

An acceptable amount				An unacceptable amount
1	2	3	4	5

Category	*Time spent (approximate)*
1. "An acceptable amount"	______________________
5. "An unacceptable amount"	______________________

____

____

____

____

6. During peak workload conditions; i.e., when you are performing a difficult instrument approach procedure to an unfamiliar airfield, what is the *maximum* percentage of time you spend in the terminal area interpreting and selecting approach information? Please comment on your interpretation of how much time comprises these categories.

An acceptable amount				An unacceptable amount
1	2	3	4	5

Category	*Time spent (approximate)*
1. "An acceptable amount"	______________________
5. "An unacceptable amount"	______________________

7. Instead of "hand flying" the approach, assume that you are performing an autoflight approach. Please describe any differences in the time spent interpreting approach information.

8. Do you feel that it is possible to make errors in the cockpit that can be directly attributed to charting considerations? If yes, please comment on the nature of these errors.

( ) Yes ( ) No

9. What are the most common errors you make or are aware that others have made reading the instrument approach plate?

10. What mistakes, if any, have you made looking for communication frequencies?

11. Do you require the same approach information for a precision and nonprecision approach? If no, what information is different?

( ) Yes ( ) No

12. Do you follow a certain procedure that allows you to have access to a full set of NOTAMS?

( ) Yes ( ) No

13. Have you ever observed anyone using noncurrent charts?

Never				Frequently
1	2	3	4	5

14. Under which conditions do you experience more problems reading the chart? Please comment on what information is hard to read.

( ) Bright Light ( ) Low Light

Please answer the following three questions only if you use both Jeppeson-Sanderson and NOAA charts:

1. What problems do you encounter when switching back and forth from NOAA charts to Jeppeson-Sanderson charts?

2. Do you confuse the primary navaid frequency for the approach with other navaid frequencies? If yes, please comment.

( ) Yes ( ) No

3. Is a major change in approach chart format warranted or desirable? If yes, please comments.

( ) Yes ( ) No

Please answer the following two questions only if you have any experience flying nonprecision loran approaches.

1. Have you flown loran approaches as part of recreational flying?

2. What are the problems, if any, that you have experienced while flying these approaches?

C. Factors Affecting Chart Clutter

Chart clutter can degrade pilot performance by detracting from his/her ability to extract relevant information from the IAP to perform an instrument approach procedure.

The following represents a nonexhaustive list of categories of information that can contribute to approach chart clutter.

1. *Chart Identification Information*
2. *Airport Identification*
3. *Terrain Information*
4. *Navigation Waypoints*
5. *Routing Procedures*
6. *Missed Approach Information*
7. *Communication Frequencies*
8. *Minimum altitudes*
9. *Airport Notes*

An example from each of these categories (if applicable) is shown on the following page (Figure I). Each sample IAP contained throughout this document has been reduced to 95% of its original size.

- ***THESE CHARTS HAVE BEEN REPRODUCED FOR ILLUSTRATIVE PURPOSES ONLY***

NOT FOR NAVIGATION

Information Categories Contributing to Chart Clutter

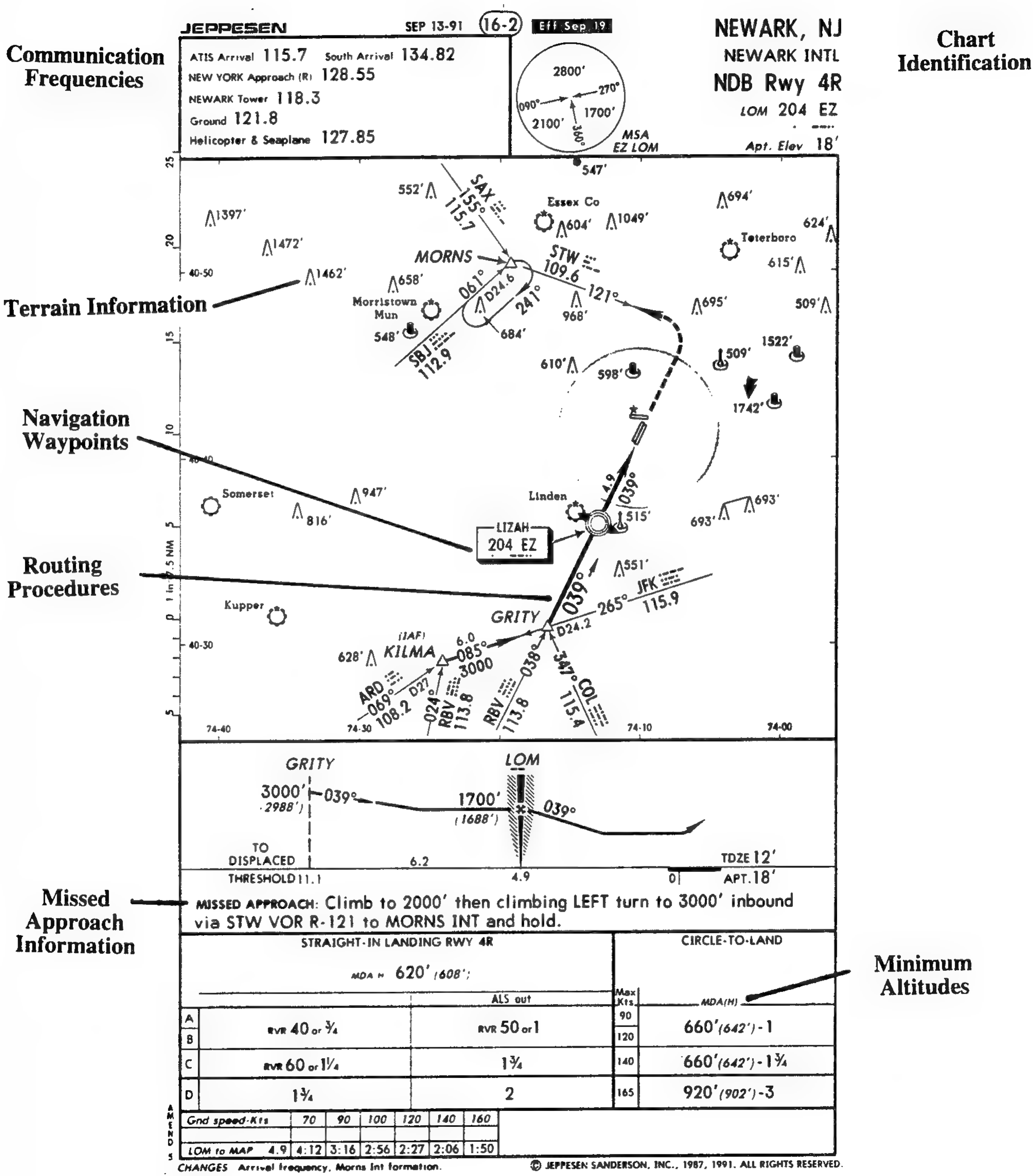


FIGURE I.

Using the scale provided, please indicate how much each category contributes to chart clutter.

1.	Chart Identification Info	1 No clutter	2	3	4	5 Significant clutter
2.	Airport Information	1 No clutter	2	3	4	5 Significant clutter
3.	Terrain Information	1 No clutter	2	3	4	5 Significant clutter
4.	Navigation Waypoints	1 No clutter	2	3	4	5 Significant clutter
5.	Routing Procedures	1 No clutter	2	3	4	5 Significant clutter
6.	Missed Approach Information	1 No clutter	2	3	4	5 Significant clutter
7.	Communication Frequencies	1 No clutter	2	3	4	5 Significant clutter
8.	Minimum Altitudes	1 No clutter	2	3	4	5 Significant clutter

Please comment on how you might like to reduce approach chart clutter.

____
____
____
____

More on Approach Chart Clutter

1. Would you like to see the level of terrain information on the IAP increased or decreased? Please comment.

( ) Increased ( ) Decreased

____
____
____

2. Trade-offs exist between the presentation of terrain information and chart clutter. HOW should terrain information be presented? Some possibilities are the depiction of "spot elevations," i.e., height of communication towers, prominent terrain features, or the depiction of terrain contours in color. Please comment.

____
____
____
____

D. Operator Preferences

1. Do you use the IAP while landing in VFR conditions?

( ) Yes ( ) No

2. How do you use an IAP differently, if at all, if you are familiar/unfamiliar with the airport?

____
____
____
____

3. Does your company require you to brief an instrument approach procedure in a specified manner?

( ) Yes ( ) No

4. If not, do you brief an instrument approach procedure the way you were *initially* trained?

( ) Yes ( ) No

5. Procedurally, do you brief a precision and nonprecision approach procedure in the same manner?

( ) Yes ( ) No

The following page (Figure II) contains a sample Jeppeson-Sanderson IAP. Please highlight in yellow the information you normally include in your approach brief, if applicable.

NOT FOR NAVIGATION

Information Content of Your Instrument Approach Brief

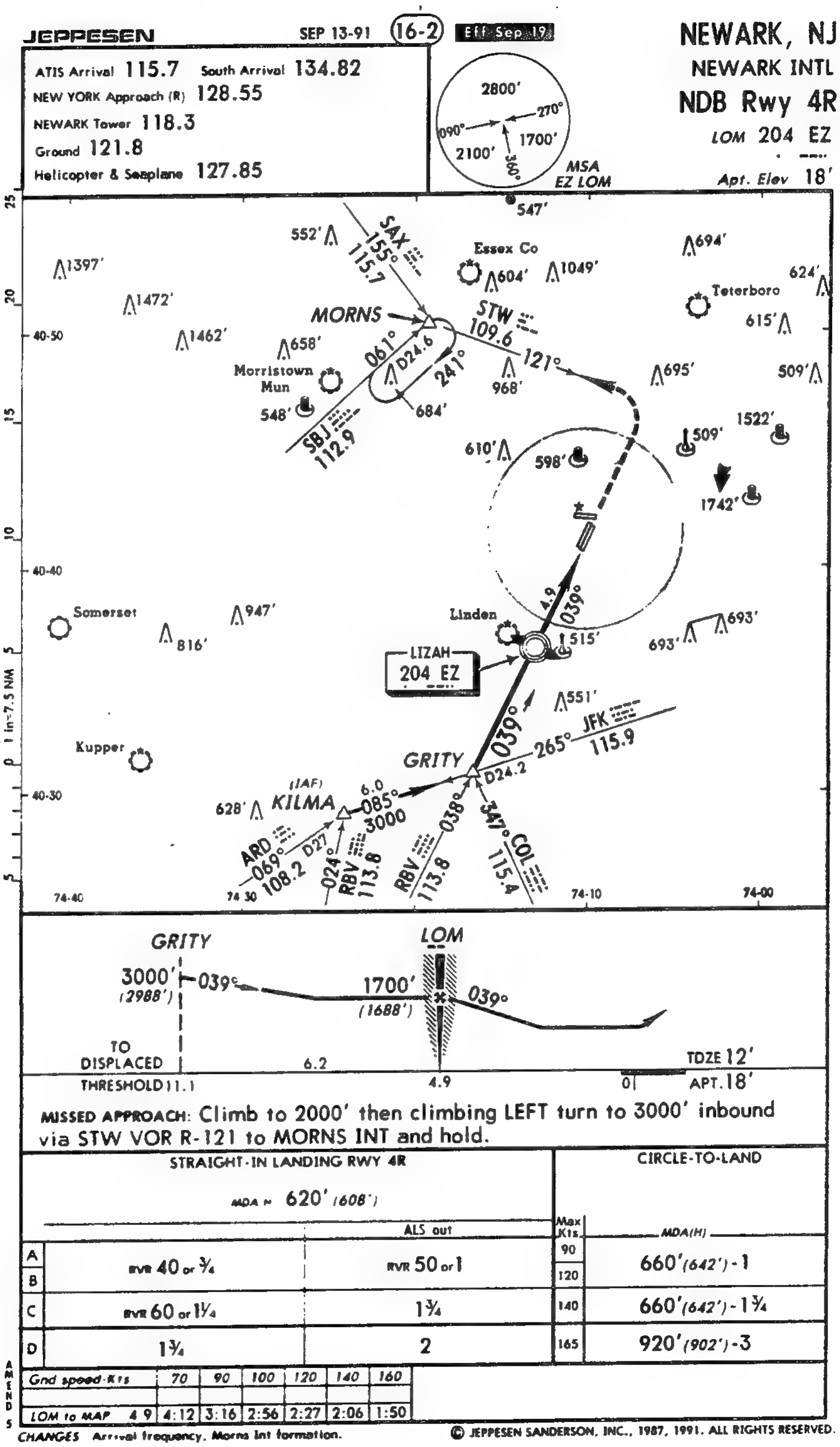


FIGURE II.

III. APPROACH PLATE INFORMATION ANALYSIS

A. Purpose

Depending on company training policy and/or aviation background, pilots/flight crews may group, and subsequently utilize, the information contained on an IAP differently. We would like to determine the instrument approach information pilots would prefer to have available to them as it pertains to phase of flight.

Individuals within the Aeronautical Systems Laboratory have subjectively divided an instrument approach procedure into four phases of flight. It should be noted here that the phases of flight remain constant for both precision and nonprecision approaches. They are as follows:

1. *Pre-Approach (Prior to arrival in the terminal area)*

2. *Approach (Execution of the approach procedure)*

3. *Missed Approach (If required)*

4. *Ground Operations (Taxi for take-off, taxi to parking)*

Assume IFR conditions, and flight operations conducted in a radar controlled environment.

B. Procedure

On each of the following pages (Figures III-IX), sample Jeppeson-Sanderson precision and nonprecision approach plates are provided for each of the four instrument approach phases of flight.

a. ILS 13R at Kennedy

You will be approaching from the north and can expect to receive vectors to intercept the localizer.

B. NDB 4R to Newark

You will be approaching from the south and have been told to expect your own navigation direct to "Grity".

C. Directions

Please evaluate the information content of both the precision and nonprecision IAP as it pertains to phase of flight in the following manner.

• Using the *yellow* highlighter, indicate the information you feel is critical to have access to during the given phase of flight. For example, if you feel that it is critical to have missed approach information available to you during the pre-approach phase of flight, highlight this information.

• Using the *pink* highlighter, highlight the information you would suppress if you had the opportunity to customize the IAP for this particular phase of flight.

• Please note that each piece of information contained on the plate *does not* have to be highlighted.

NOT FOR NAVIGATION

Phase I: Pre-Approach (Prior to entering the terminal area)
A. Precision Approach

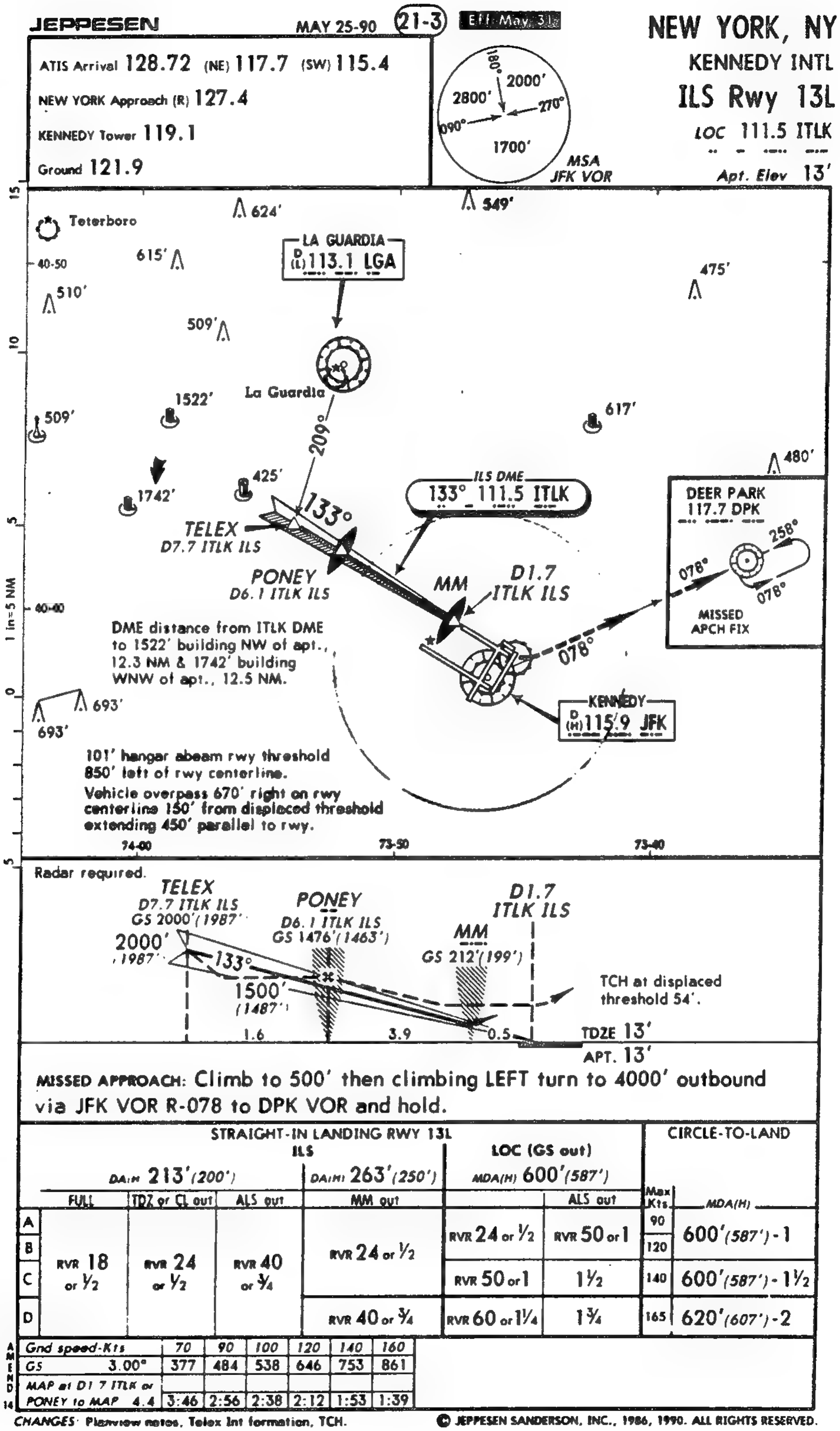
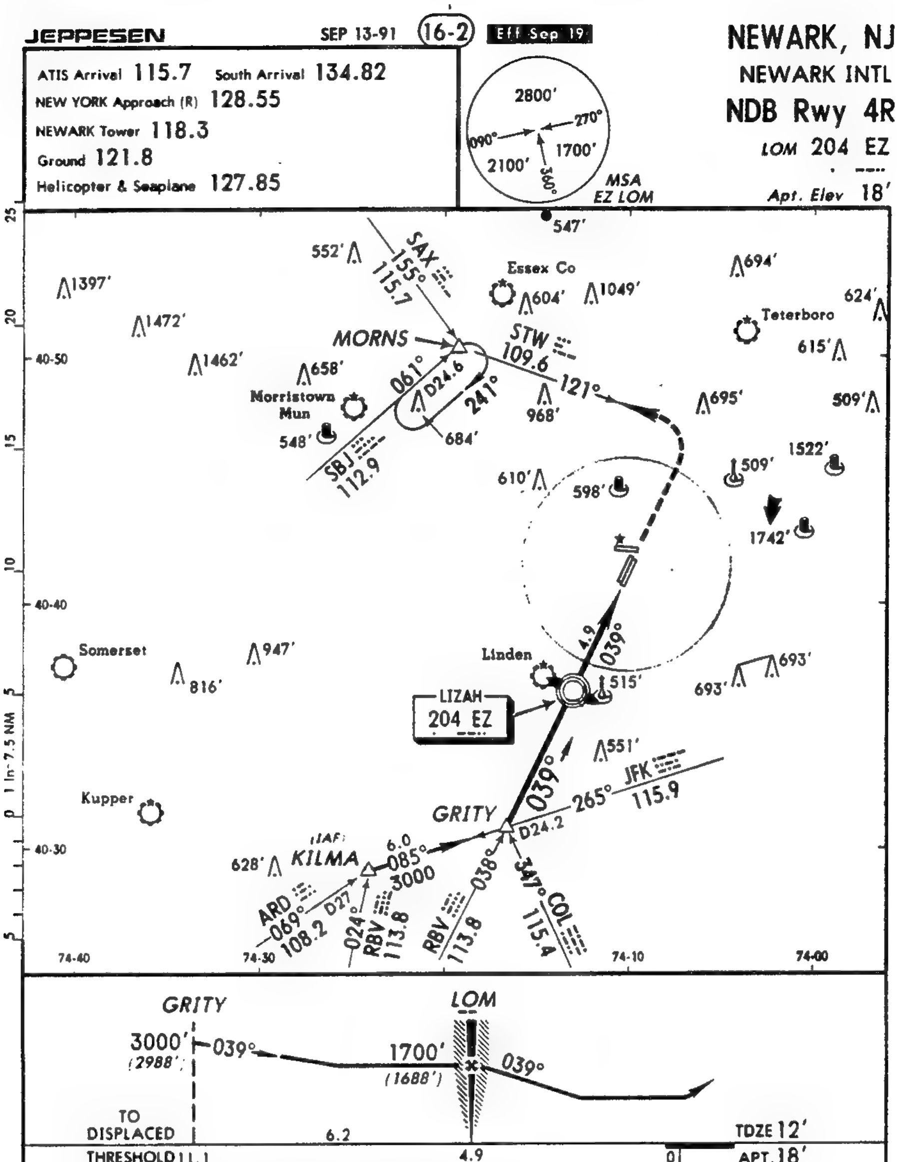


FIGURE III.

NOT FOR NAVIGATION

Phase I: Pre-Approach (Prior to entering the terminal area)
B. Non-Precision Approach



MISSED APPROACH: Climb to 2000' then climbing LEFT turn to 3000' inbound via STW VOR R-121 to MORNS INT and hold.

	STRAIGHT-IN LANDING RWY 4R MDA(H) 620' (608')	ALS out	Max Kts	CIRCLE-TO-LAND MDA(H)
A	RVR 40 or ¾	RVR 50 or 1	90	660'(642')-1
B			120	
C	RVR 60 or 1¼	1¾	140	660'(642')-1¾
D	1¾	2	165	920'(902')-3

Gnd speed-Kts	70	90	100	120	140	160
LOM to MAP 4.9	4:12	3:16	2:56	2:27	2:06	1:50

CHANGES: Arrival frequency, Morns Int formation.

FIGURE IV.

NOT FOR NAVIGATION

Phase II: Approach
A. Precision Approach

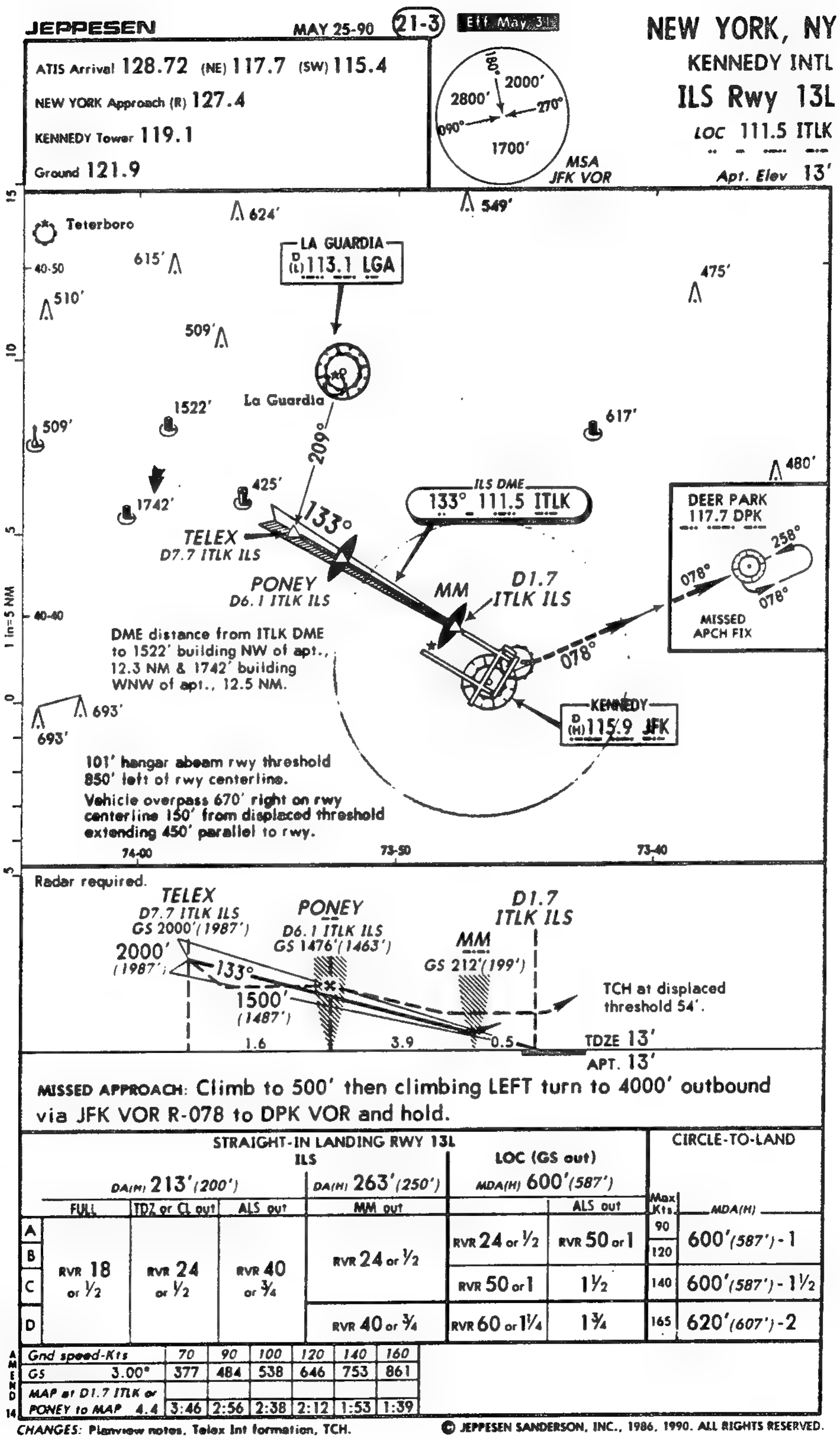
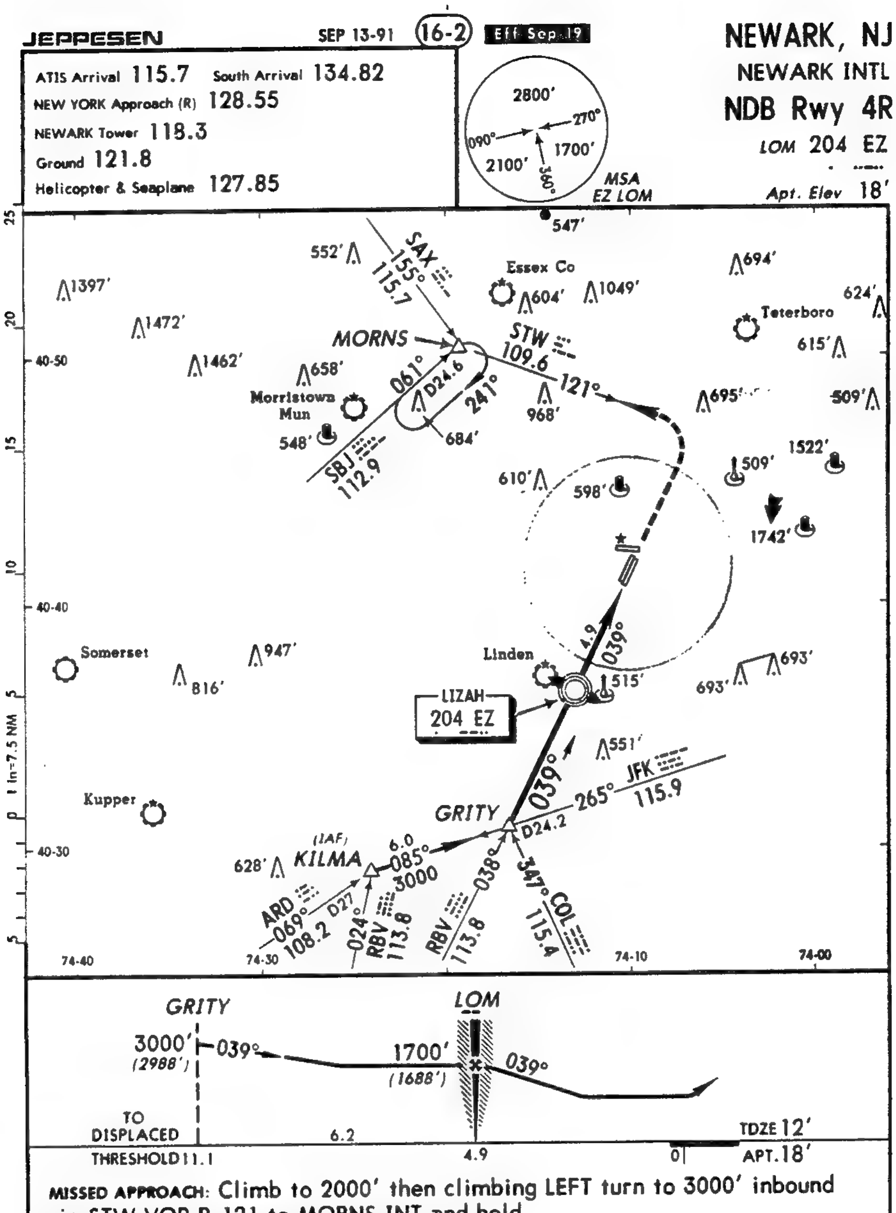


FIGURE V.

Phase II: Approach
B. Non-Precision Approach



	STRAIGHT-IN LANDING RWY 4R MDA(H) 620' (608')	ALS out	Max Kts	CIRCLE-TO-LAND MDA(H)
A	RVR 40 or ¾	RVR 50 or 1	90	660' (642')-1
B			120	
C	RVR 60 or 1¼	1¾	140	660' (642')-1¾
D	1¾	2	165	920' (902')-3

Gnd speed-Kts		70	90	100	120	140	160
LOM to MAP	4.9	4:12	3:16	2:56	2:27	2:06	1:50

CHANGES: Arrival frequency, Morns Int formation.

FIGURE VI.

NOT FOR NAVIGATION

Phase III: Missed Approach
A. Precision Approach

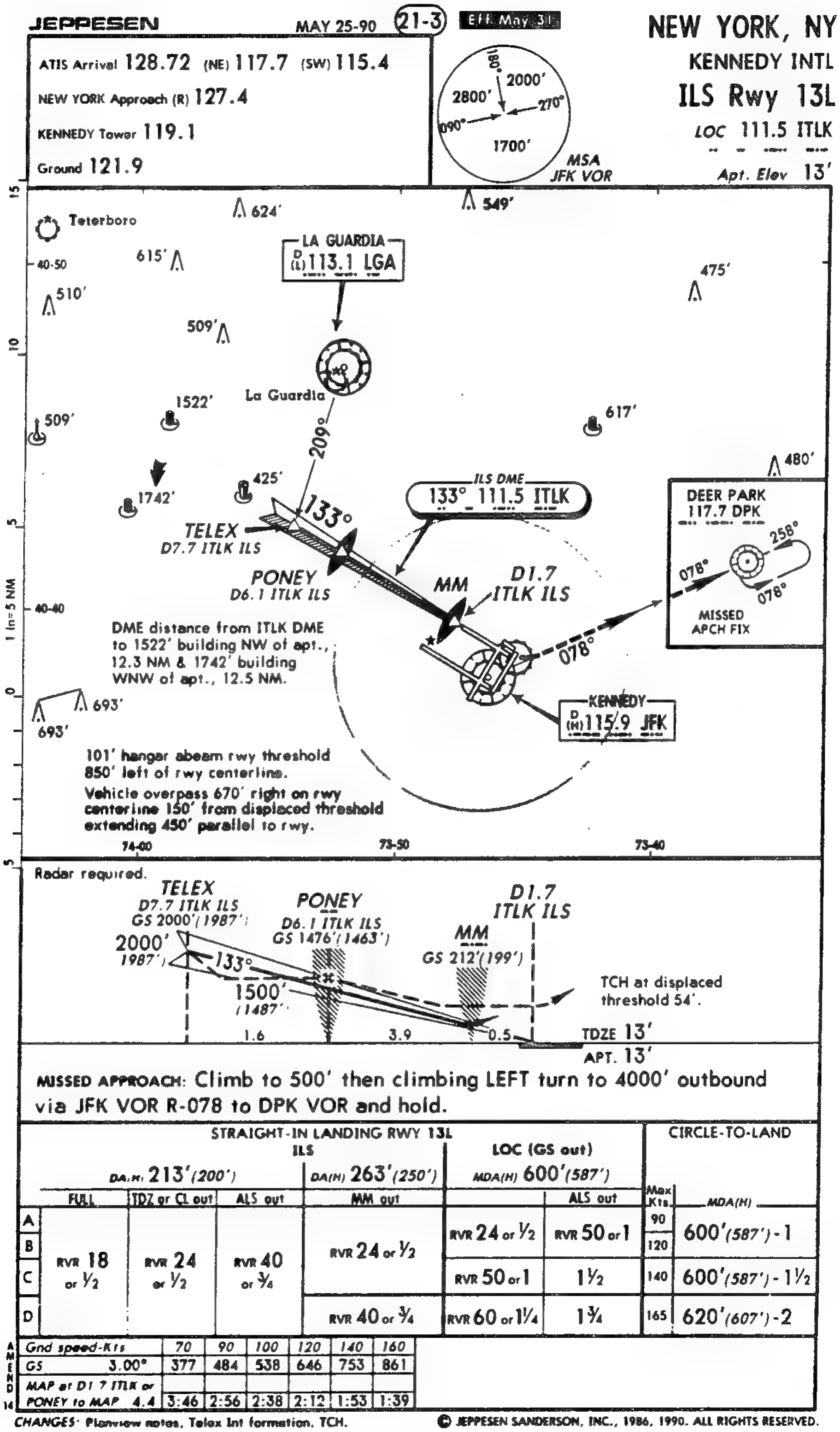


FIGURE VII.

NOT FOR NAVIGATION

Phase III: Missed Approach
B. Non- Precision Approach

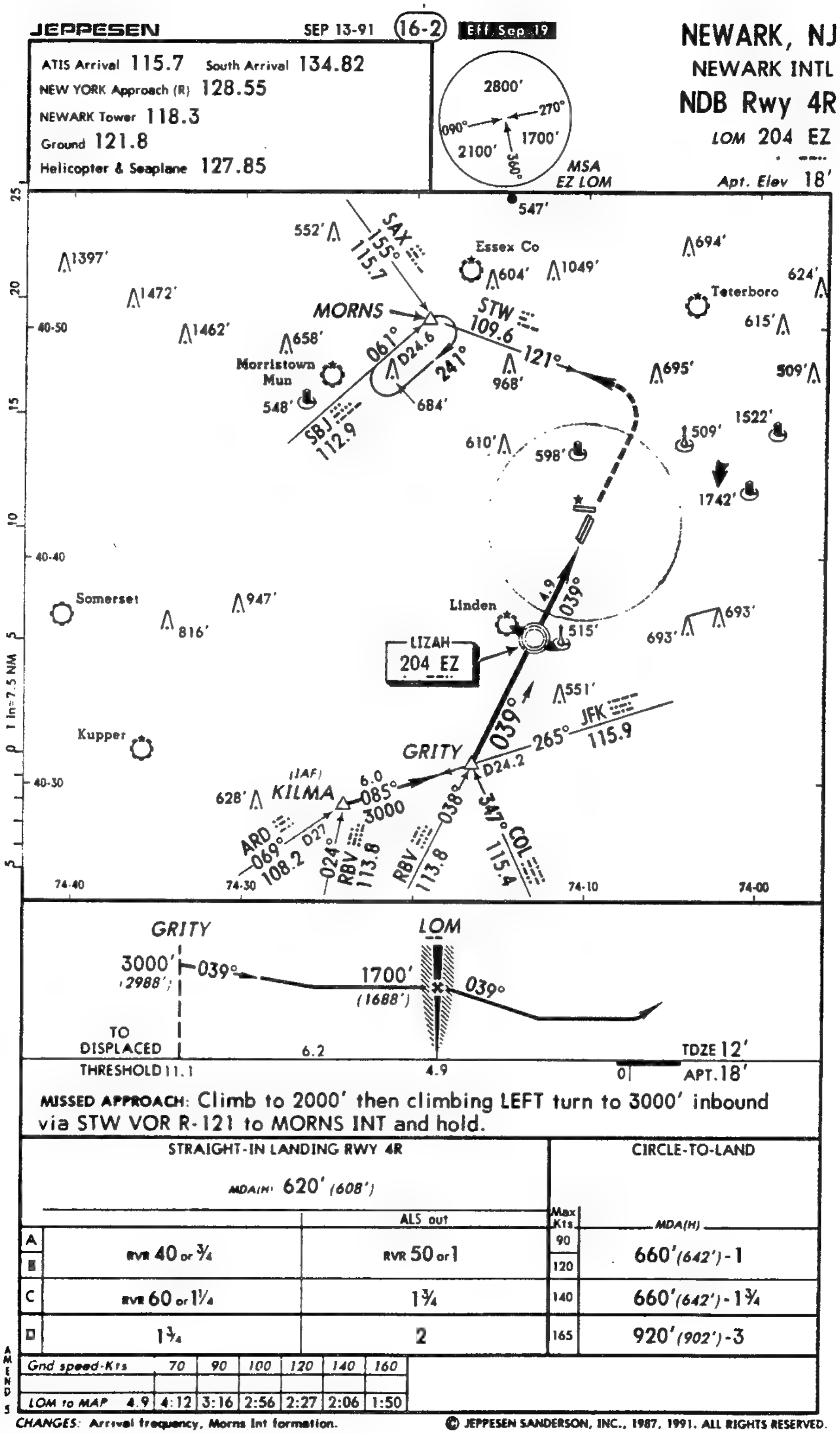


FIGURE VIII.

Phase IV: Ground Operations

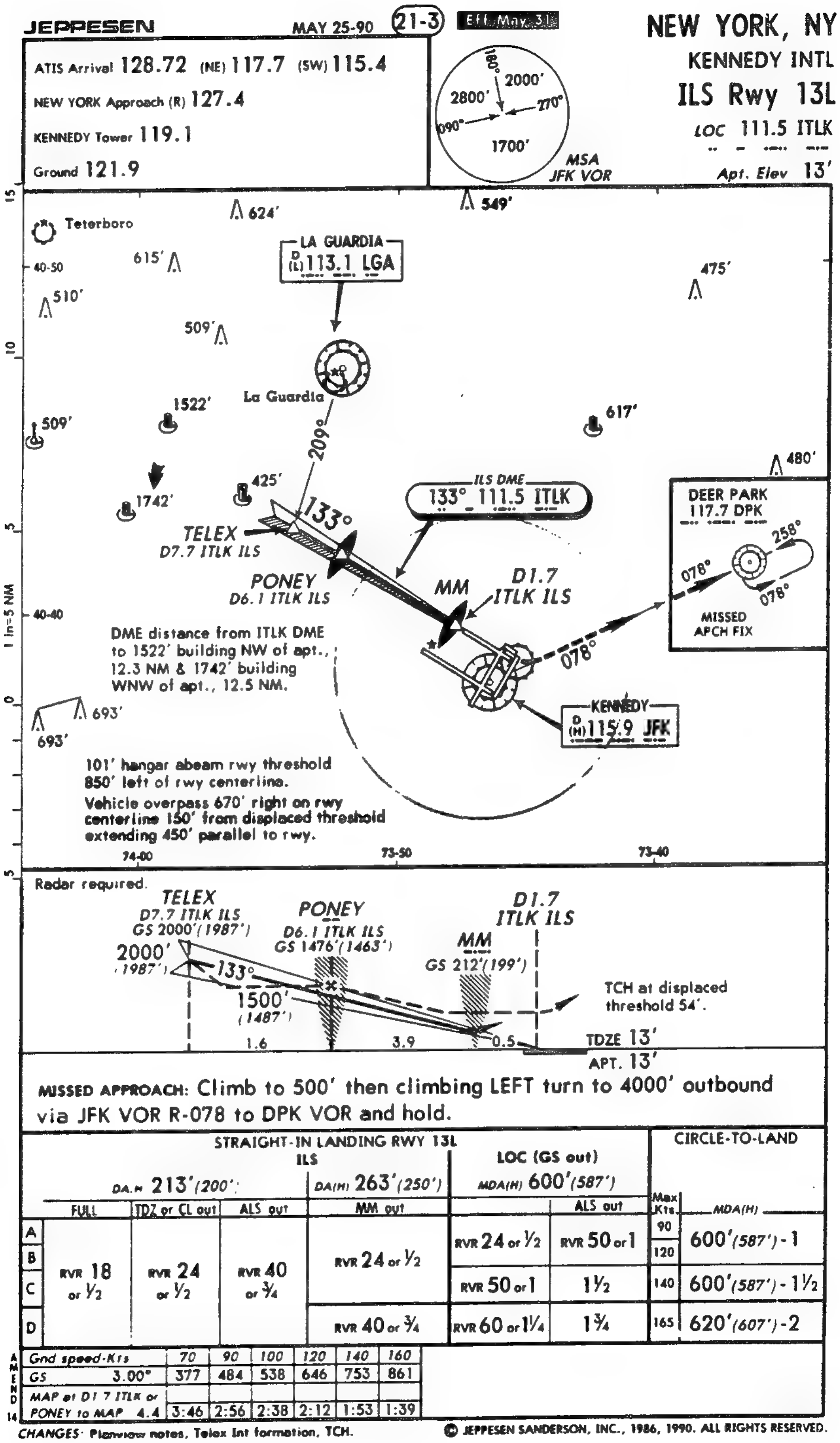


FIGURE IX.

IV. ELECTRONIC APPROACH CHARTS

A. Purpose

Replication of paper approach plates in electronic format may limit the amount of approach information available to the pilot due to limitations in display technology. However, electronic approach plates may also provide the pilot with the flexibility to select only desired approach information.

The following questions seek to determine your preferences regarding some of the options currently available for electronic replication of approach plates, given the available technology.

1. Would you favor the replication of paper instrument approach plates in electronic format?

( ) Yes ( ) No

2. Would you feel comfortable using solely electronic plates with no paper approach plates available as a back-up?

____

____

____

____

3. Two prototype designs for electronic approach plates are static and dynamic. The static plate is a replication of the paper chart with a north-up orientation, while the dynamic chart has a moving map platform view similar to the EHSI and a track-up orientation. Which would you prefer and why?

____

____

____

____

For the following three questions, "customizing" an approach plate refers to being able to select or deselect approach information of your choice in an attempt to have a "cleaner" presentation with reduced chart clutter. Selection of information could be accomplished prior to departure; however, all information would be constantly accessible to you at any time you desire to select it. Also, in the event of a missed approach, missed approach information will automatically be displayed.

4. Would you find it desirable to be able to customize your approach plate? Why?

( ) Yes ( ) No

____

____

____

____

5. Would this procedure cause a significant workload increase during the approach phase of flight? How?

( ) Yes ( ) No

____

____

____

6. Would you require the same information display if you were hand flying the approach as opposed to performing an autoflight approach? If yes, how?

( ) Yes ( ) No

7. Would a moving map display of the airport be useful while taxiing to the gate?

( ) Yes ( ) No

CONCLUSION

The information you have provided will be extremely useful in our research. Your participation in this survey is greatly appreciated.

Please keep the highlighters, and return the survey to us as soon as possible; preferably within one week of receipt. Thank you again for your participation!

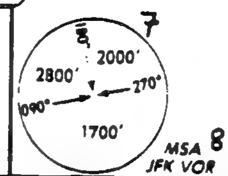
APPENDIX B

Information Element Key

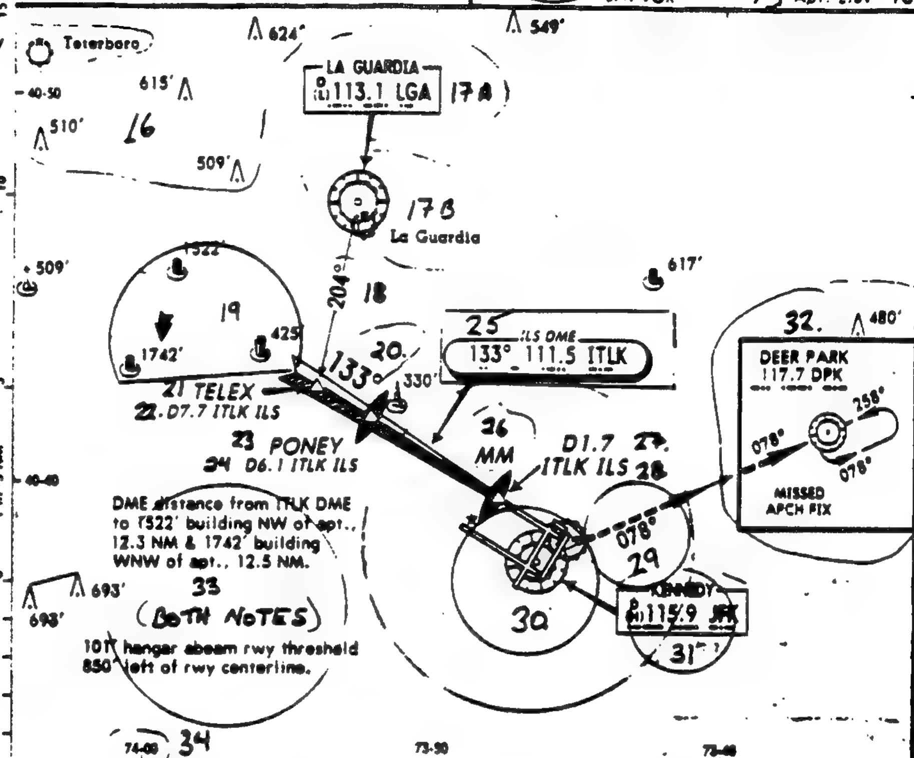
Precision Approach

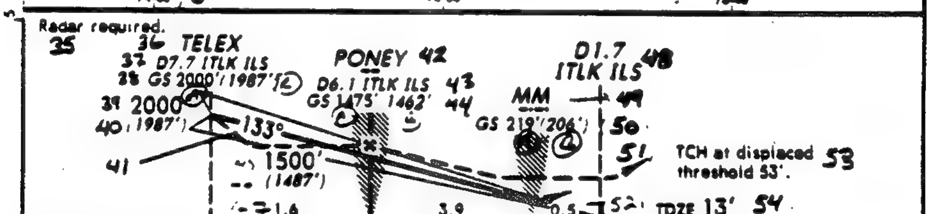
JEPPESEN SEP 29-89 1 (21-3) 2

3	ATIS Arrival 128.72 NE 117.7 SW 115.4
4	NEW YORK Approach R 127.4
5	KENNEDY Tower 119.1
6	Ground 121.9



9 NEW YORK, NY
10 KENNEDY INTL
11 ILS Rwy 13L
12 LOC 111.5 ITLK
13 Apt. Elev 13'





56
MISSED APPROACH: Climb to 500' then climbing LEFT turn to 4000' outbound via JFK VOR R-078 to DPK VOR and hold.

	STRAIGHT-IN LANDING RWY 13L 57 ILS DA(H) 213'(200')			DA(H) 263' 250'	LOC (GS out) MDA(H) 600'(587')		CIRCLE-TO-LAND 59	
	FULL	TDZ or CL out	ALS out	MM out		ALS out	Max Kts	MDA(H)
A	RVR 18 or 1/2	(61) RVR 24 or 1/2	RVR 40 or 3/4	RVR 24 or 1/2	RVR 24 or 1/2	RVR 50 or 1	90	600'(587')-1
B							120	
C					RVR 50 or 1	1 1/2	140	600'(587')-1 1/2
D	RVR 20 or 1/2			RVR 40 or 3/4	RVR 60 or 1 1/4	1 3/4	165	620'(607')-2

63	Gnd speed-Kts	70	90	100	120	140	160
65	GS 3.00°	377	484	538	646	753	861
67	MAP at D1.7 ITLK or PONEY to MAP 4.4	3:46	2:56	2:38	2:12	1:53	1:39

69 CHANGES: LOC (GS out) & circling minimums.

INFORMATION ELEMENT KEY

ILS Rwy 13L, Kennedy INTL

Element Number	Element Description
1	Approach Plate Date
2	Approach Plate Page
3	ATIS Arrival Frequency
3 B	ATIS Arrival Frequency (NE)
3 C	ATIS Arrival Frequency (SW)
4	Approach Frequency
5	Tower Frequency
6	Ground Frequency
7	MSA Altitude Depiction
8	MSA Identifier
9	City
10	Airport
11	Approach
12	Localizer Frequency
13	Airport Elevation
14	Teterboro Airport
15	Numerical Scaling
16	Obstacles
17 A	La Guardia VOR Frequency
17 B	La Guardia VOR
18	Cross Radial Heading
19	Final Approach Course Obstacles
20	ILS Course
21	IAF Name
22	ILS DME
23	FAF Name
24	FAF DME
25	ILS DME Box
26	Middle Marker
27	Middle Marker DME
28	ITLK ILS
29	Missed Approach Heading
30	Airfield Diagram
31	Kennedy VOR
32	Missed Approach Fix
33	Notes
34	Scaling
35	"Radar Required"
36	IAF Name
37	ILS DME
38 A	Glide Slope Intercept Altitude (MSL)
38 B	Glide Slope Intercept Altitude (AGL)
39	Glide Slope Intercept Altitude (MSL)
40	Glide Slope Intercept Altitude (AGL)

INFORMATION ELEMENT KEY

ILS Rwy 13L, Kennedy INTL

Element Number	Element Description
41	Final Approach Course
42	FAF Name
43	FAF DME
44 A	Glide Intercept Altitude (MSL)
44 B	Glide Intercept Altitude (AGL)
45	FAF Intercept Altitude (MSL)
46	Final Approach Fix (AGL)
47	Scaling
48	DME
49	Middle Marker
50 A	Glide Intercept Altitude (MSL)
50 B	Glide Intercept Altitude (AGL)
51	Dashed Course
52	TDZE DME
53	Note
54	TDZE
55	Airport Elevation
56	Missed Approach Instructions
57	Minimums (Category)
58	Minimums (All Other Categories)
59	Circle to Land (Category)
60	Circle to Land (All Other Categories)
61	RVR (Category)
62	RVR (All Other Categories)
63	Ground Speed (Category)
64	Ground Speed (All Other Categories)
65	Glide Slope (Category)
66	Glide Slope (All Other Categories)
67	Timing (Category)
68	Timing (All Other Categories)
70	Changes

APPENDIX C

Information Element Key

Non-Precision Approach

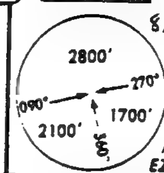
JEPPESEN DEC 8-89 16-2 Eff Dec 14

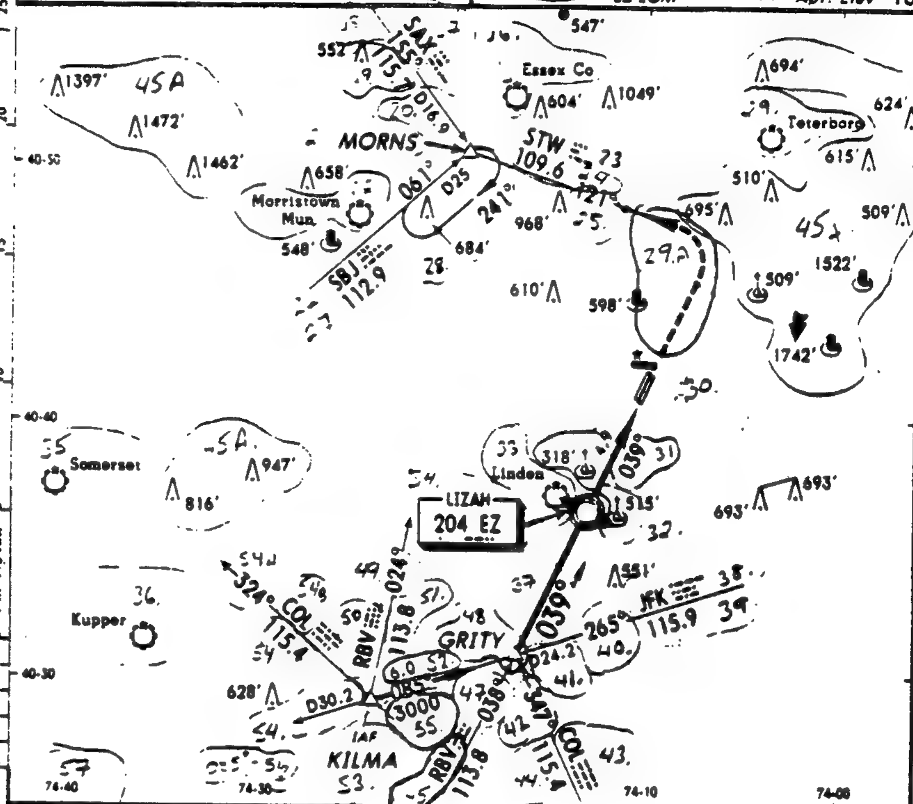
NEWARK, NJ
NEWARK INTL
NDB Rwy 4R

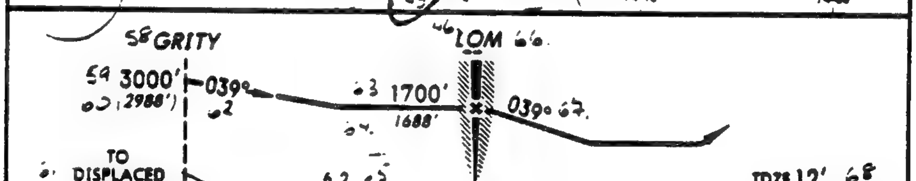
NDB 204 EZ

Apt. Elev 18'

ATIS Arrival	115.7
NEW YORK Approach R	128.55
NEWARK Tower	118.3
Ground	121.8
Helicopter & Seaplane	127.85







MISSED APPROACH: Climb to 2000' then climbing LEFT turn to 3000' inbound via STW VOR R-121 to MORNS INT and hold.

	STRAIGHT-IN LANDING RWY 4R MDA(H) 620' 608'	ALS out	Max Kts	CIRCLE-TO-LAND MDA(H)
A	RVR 40 or ¾	RVR 50 or 1	90	660'(642')-1
B			120	
C	RVR 60 or 1¼	1¾	140	660'(642')-1¾
D	1¾	2	165	920'(902')-3

Gnd speed-Kts	70	90	100	120	140	160
LOM to MAP 4.9	4:12	3:16	2:56	2:27	2:06	1:50

CHANGES: See other side.

INFORMATION ELEMENT KEY

NDB Rwy 4R, Newark INTL

Element Number	Element Description
1	Approach Plate Date
2	Approach Plate Page
3	ATIS Arrival Frequency
4	Approach Frequency
5	Tower Frequency
6	Ground Frequency
7	Helicopter and Sea Plane Frequency
8	MSA Altitude Depiction
9	MSA Identifier
10	City
11	Airport
12	Approach Identification
13	NDB Frequency
14	Airport Elevation
15	Numerical Scaling
16	Essex Co Airport
17	Cross Radial Identifier (SAX)
18	Cross Radial Heading (155)
19	SAX Frequency
20	DME to Fix (MORNS Intersection)
21	MORNS Intersection
22	MORNS Town Municipal Airport
23	Cross Radial Identifier (STW)
24	STW Frequency
25	Cross Radial Heading (121)
26	Cross Radial Identifier (SBJ)
27	SBJ Frequency
28	Map Holding Fix (061,241)
29	Teterboro Airport
29 A	Missed Approach Course
30	Airfield Diagram
31	Final Approach Course Heading (LOM Inbound)
32	Final Approach Course Obstacles
33	Linden Airport
34	LOM Frequency
35	Somerset Airport
36	Kupper Airport
37	Final Approach Course (Inbound to LOM)
38	Cross Radial Identifier (JFK)
39	JFK Frequency
40	Cross Radial Heading (265)
41	Cross Radial DME to Fix (Grity Intersection)
42	Cross Radial Heading (347)
43	Cross Radial Identifier (COL)
44	COL Frequency

INFORMATION ELEMENT KEY

NDB Rwy 4R, Newark INTL

Element Number	Element Description
45	Cross Radial Identifier (RBV)
45 A	Obstacles
46	RBV Frequency
47	Cross Radial Heading (038)
48	"Grity"
49	Cross Radial Heading (024)
50	Cross Radial Identifier (RBV)
51	RBV Frequency
52	DME (6.0 IAF to Grity)
54	IAF (Kilma)
55	COL Frequency
54 A	Cross Radial Heading (324)
54 B	Cross Radial Identifier (COL)
54 C	DME (IAF to JFK)
55	IAF Intercept Altitude (3 K to Grity)
56	Course from IAF to Grity (085)
57	Scaling
58	Grity (Profile View)
59	Intercept Altitude (MSL)
60	Intercept Altitude (AGL)
61	Note
62	Final Approach Course
63	FAF Intercept Altitude (MSL)
64	FAF Intercept Altitude (AGL)
65	DME
66	LOM (Depiction)
67	Final Approach Course Inbound (039)
68	TDZE
69	Airport Elevation
70	Missed Approach Instructions
71	Minimums
72	Circle to Land (Category)
73	Circle to Land (All Other Categories)
74	RVR (Category)
75	RVR (All Other Categories)
76	Ground Speed (Category)
77	Ground Speed (All Other Categories)
78	Timing (Category)
79	Timing (All Other Categories)
80	Changes

APPENDIX D

Information Element Ranking per Phase of Flight

Precision Approach

Precision Approach

Element Ranking per Phase of Flight

Information Element Number	Information Element Description	Ranking in Pre-Approach Phase	Ranking in Approach Phase	Ranking in Missed Approach Phase	Ranking in Ground Operations Phase
1	Approach Plate Date	27	51	15	7
2	Approach Plate Page	50	52	16	8
3	ATIS Arrival Frequency	10	58	17	3
3 B	ATIS Arrival Frequency (NE)	16	65	19	5
3 C	ATIS Arrival Frequency (SW)	17	66	20	6
4	Approach Frequency	28	53	4	4
5	Tower Frequency	18	7	8	2
6	Ground Frequency	36	28	10	1
7	MSA Altitude Depiction	11	63	5	16
8	MSA Identifier	21	54	18	15
9	City	7	40	11	13
10	Airport	6	29	9	9
11	Approach	1	12	12	10
12	Localizer Frequency	13	13	14	14
13	Airport Elevation	12	26	21	11
14	Teterboro Airport	73	74	69	21
15	Numerical Scaling	71	73	57	22
16	Obstacles	74	75	74	23
17 A	La Guardia VOR Frequency	14	69	68	68
17 B	La Guardia VOR	45	72	44	69
18	Cross Radial Heading	51	64	50	24
19	Final Approach Course Obstacles	69	70	70	25
20	ILS Course	2	4	28	26
21	IAF Name	29	30	29	27
22	ILS DME	37	31	30	28
23	FAF Name	52	55	22	29
24	FAF DME	53	41	23	30
25	ILS DME Box	3	2	24	17
26	Middle Marker	46	32	27	31
27	Middle Marker DME	60	42	31	32
28	ITLK ILS	61	43	32	33
29	Missed Approach Heading	22	14	2	34
30	Airfield Diagram	38	27	6	12
31	Kennedy VOR	9	21	7	18
32	Missed Approach Fix	39	15	3	35
33	Notes	75	71	51	36
34	Scaling	70	67	36	37
35	"Radar Required"	54	59	58	38
36	IAF Name	55	8	52	39

Precision Approach

Element Ranking per Phase of Flight (cont.)

Information Element Number	Information Element Description	Ranking in Pre-Approach Phase	Ranking in Approach Phase	Ranking in Missed Approach Phase	Ranking in Ground Operations Phase
37	ILS DME	40	16	37	40
38 A	Glide Slope Intercept Altitude (MSL)	15	23	45	70
38 B	Glide Slope Intercept Altitude (AGL)	47	25	46	71
39	Glide Slope Intercept Altitude (MSL)	41	9	38	41
40	Glide Slope Intercept Altitude (AGL)	56	44	39	42
41	Final Approach Course	23	10	33	43
42	FAF Name	30	11	40	44
43	FAF DME	31	17	41	45
44 A	Glide Intercept Altitude (MSL)	32	5	47	72
44 B	Glide Intercept Altitude (AGL)	42	20	48	73
45	FAF Intercept Altitude (MSL)	33	18	53	46
46	Final Approach Fix (AGL)	57	45	54	47
47	Scaling	62	56	55	48
48	DME	58	22	25	49
49	Middle Marker	65	46	56	50
50 A	Glide Intercept Altitude (MSL)	66	36	49	74
50 B	Glide Intercept Altitude (AGL)	68	39	35	75
51	Dashed Course	67	60	42	51
52	TDZE DME	59	24	59	52
53	Note	72	61	43	53
54	TDZE	24	19	34	54
55	Airport Elevation	48	33	13	55
56	Missed Approach Instructions	8	3	1	56
57	Minimums (Category)	4	1	26	19
58	Minimums (All Other Categories)	43	34	71	57
59	Circle to Land (Category)	49	37	72	58
60	Circle to Land (All Other Categories)	63	68	73	59
61	RVR (Category)	5	6	60	20
62	RVR (All Other Categories)	25	57	75	60
63	Ground Speed (Category)	19	35	61	61
64	Ground Speed (All Other Categories)	34	47	62	62
65	Glide Slope (Category)	26	48	63	63
66	Glide Slope (All Other Categories)	35	49	64	64
67	Timing (Category)	20	38	65	65
68	Timing (All Other Categories)	44	50	66	66
69	Changes	64	62	67	67

APPENDIX E

Information Element Ranking per Phase of Flight

Non-Precision Approach

Non-Precision Approach

Element Ranking per Phase of Flight

Information Element Number	Information Element Description	Ranking in Brief Phase	Ranking in Pre-Approach Phase	Ranking in Approach Phase	Ranking in Missed Approach Phase
1	Approach Plate Date	26	41	43	23
2	Approach Plate Page	27	46	44	24
3	ATIS Arrival Frequency	28	11	62	22
4	Approach Frequency	29	33	63	15
5	Tower Frequency	30	16	11	18
6	Ground Frequency	37	42	25	25
7	Helicopter and Sea Plane Frequency	38	58	64	29
8	MSA Altitude Depiction	19	21	65	16
9	MSA Identifier	34	47	45	26
10	City	10	6	40	19
11	Airport	20	7	35	21
12	Approach Identification	6	1	26	17
13	NDB Frequency	11	13	20	20
14	Airport Elevation	21	17	32	27
15	Numerical Scaling	54	66	53	32
16	Essex Co Airport	55	84	79	39
17	Cross Radial Identifier (SAX)	56	59	54	10
18	Cross Radial Heading (155)	39	67	46	6
19	SAX Frequency	40	60	47	8
20	DME to Fix (MORNS Intersection)	57	61	55	12
21	MORNS Intersection	41	68	33	4
22	MORNS Town Municipal Airport	58	85	68	51
23	Cross Radial Identifier (STW)	35	69	21	7
24	STW Frequency	42	48	16	2
25	Cross Radial Heading (121)	43	49	13	3
26	Cross Radial Identifier (SBJ)	44	62	48	11
27	SBJ Frequency	59	50	36	13
28	Map Holding Fix (061,241)	23	54	27	5
29	Teterboro Airport	60	81	81	36
29 A	Missed Approach Heading	22	57	39	9
30	Airfield Diagram	45	55	15	14
31	FAC Heading (LOM Inbound)	15	8	4	30
32	Final Approach Course Obstacles	46	63	28	33
33	Linden Airport	47	70	29	34
34	LOM Frequency	3	2	1	35
35	Somerset Airport	61	82	82	82
36	Kupper Airport	62	83	84	83
37	Final Approach Course (Inbound to LOM)	4	9	3	40

Nonprecision Approach

Element Ranking per Phase of Flight (cont.)

Information Element Number	Information Element Description	Ranking in Brief Phase	Ranking in Pre-Approach Phase	Ranking in Approach Phase	Ranking in Missed Approach Phase
38	Cross Radial Identifier (JFK)	63	22	56	52
39	JFK Frequency	48	23	57	53
40	Cross Radial Heading (265)	64	14	58	54
41	Cross Radial DME to Fix (Grity Int)	49	18	59	41
42	Cross Radial Heading (347)	50	19	37	64
43	Cross Radial Identifier (COL)	65	24	49	65
44	COL Frequency	66	34	60	55
45	Cross Radial Heading (RBV)	67	27	50	56
45 A	Obstacles	68	79	85	81
46	RBV Frequency	69	35	51	42
47	Cross Radial Heading (038)	51	36	30	43
48	"Grity"	31	25	31	37
49	Cross Radial Heading (024)	70	71	73	66
50	Cross Radial Identifier (RBV)	71	72	74	67
51	RBV Frequency	72	73	75	57
52	DME (6.0 IAF to Grity)	73	37	69	68
53	IAF (Kilma)	74	77	83	69
54	COL Frequency	75	64	70	70
54 A	Cross Radial Heading (324)	76	75	78	78
54 B	Cross Radial Identifier (COL)	77	76	80	79
54 C	DME (IAF to JFK)	78	32	72	63
55	IAF Intercept Altitude (3 K to Grity)	79	38	76	58
56	Course from IAF to Grity (085)	80	28	67	44
57	Scaling	81	80	77	71
58	Grity (Profile View)	16	39	17	72
59	Intercept Altitude (MSL)	7	10	5	59
60	Intercept Altitude (AGL)	32	40	22	73
61	Note	82	78	41	74
62	Final Approach Course	9	29	7	60
63	FAF Intercept Altitude (MSL)	5	5	2	75
64	FAF Intercept Altitude (AGL)	33	42	14	76
65	DME	52	74	34	80
66	LOM (Depiction)	17	51	9	77
67	Final Approach Course Inbound (039)	12	30	6	45
68	TDZE	18	31	18	61
69	Airport Elevation	83	65	52	28
70	Missed Approach Instructions	2	15	19	1
71	Minimums	1	3	8	31
72	Circle to Land (Category)	24	26	42	46

Nonprecision Approach

Element Ranking per Phase of Flight (cont.)

Information Element Number	Information Element Description	Ranking in Brief Phase	Ranking in Pre-Approach Phase	Ranking in Approach Phase	Ranking in Missed Approach Phase
73	Circle to Land (All Other Categories)	84	52	71	47
74	RVR (Category)	14	4	23	84
75	RVR (All Other Categories)	53	44	66	85
76	Ground Speed (Category)	13	20	12	48
77	Ground Speed (All Other Categories)	36	53	38	49
78	Timing (Category)	8	12	10	38
79	Timing (All Other Categories)	25	45	24	50
80	Changes	85	56	61	62

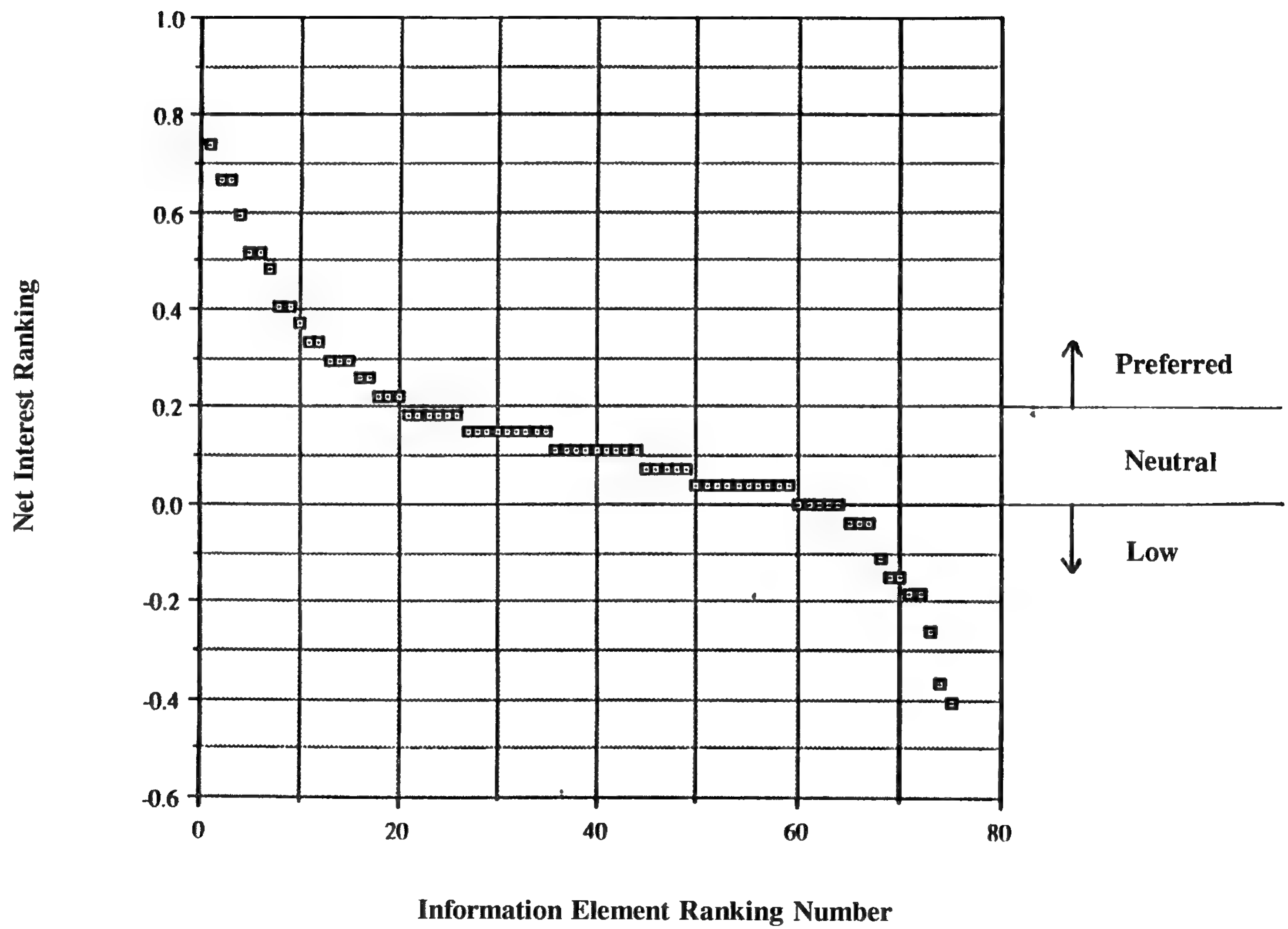
APPENDIX F

Net Interest Ranking Curves

Precision Approach

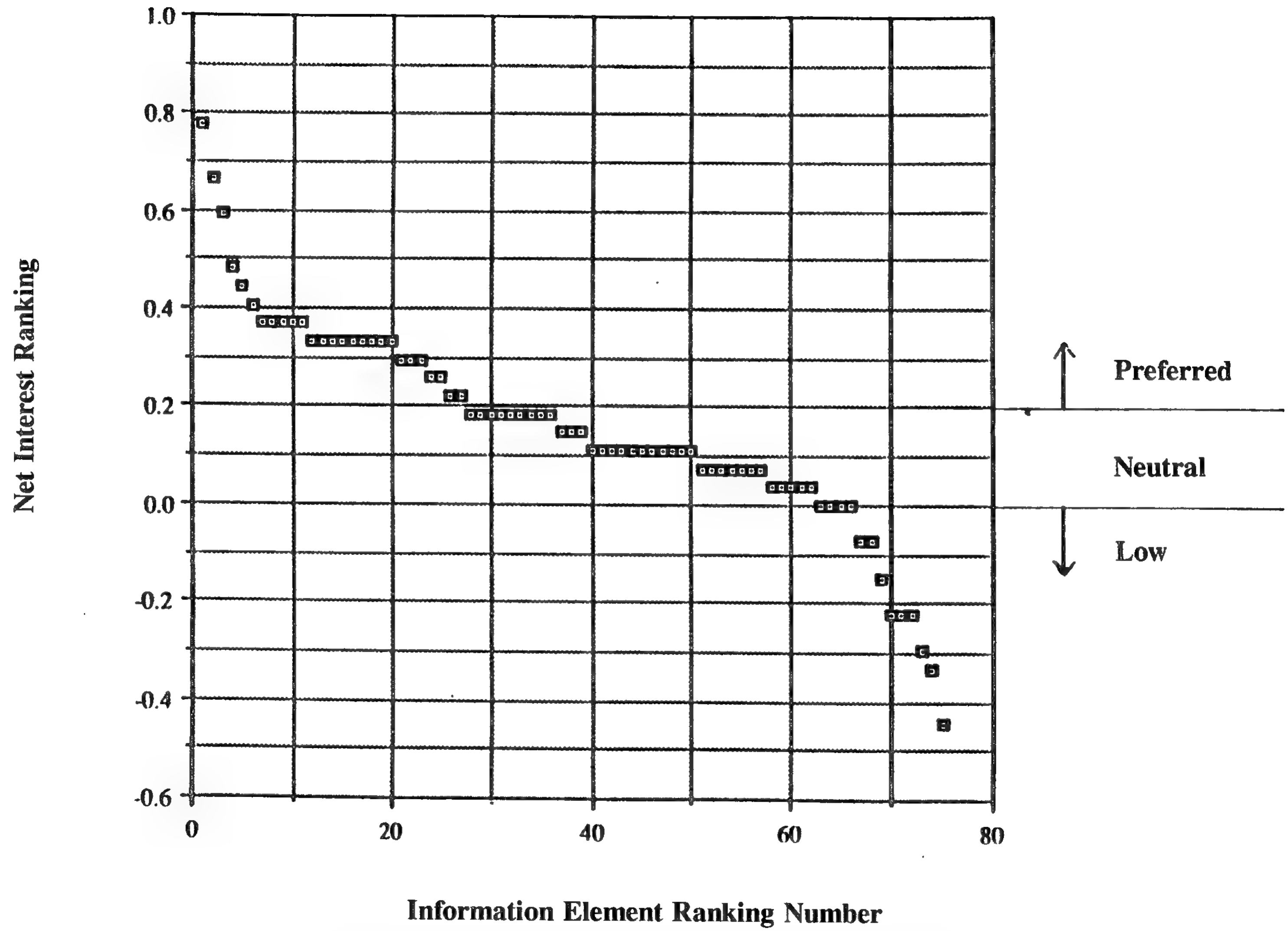
Precision Approach

Pre-Approach Phase of Flight



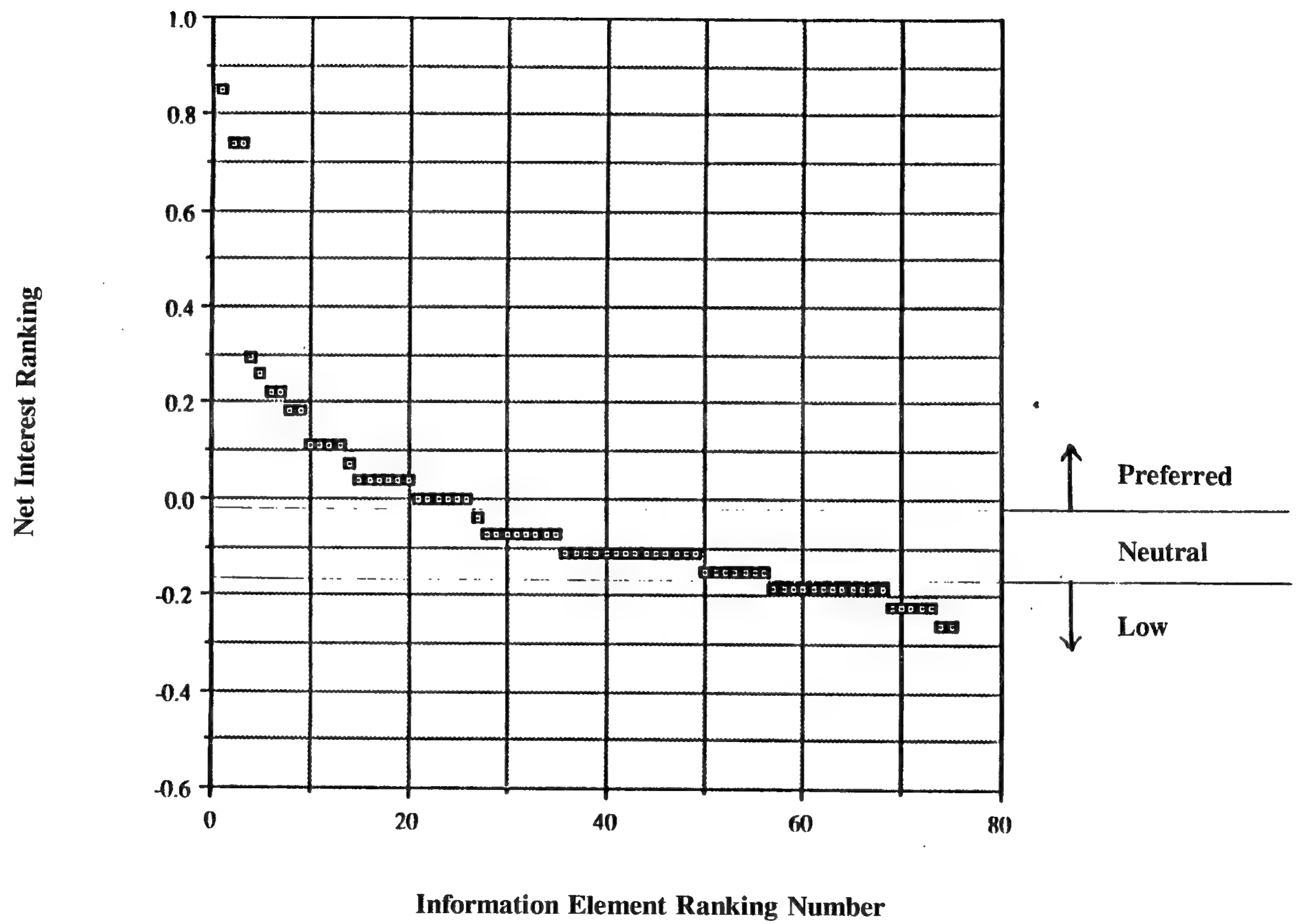
Precision Approach

Approach Phase of Flight



Precision Approach

Missed Approach Phase of Flight



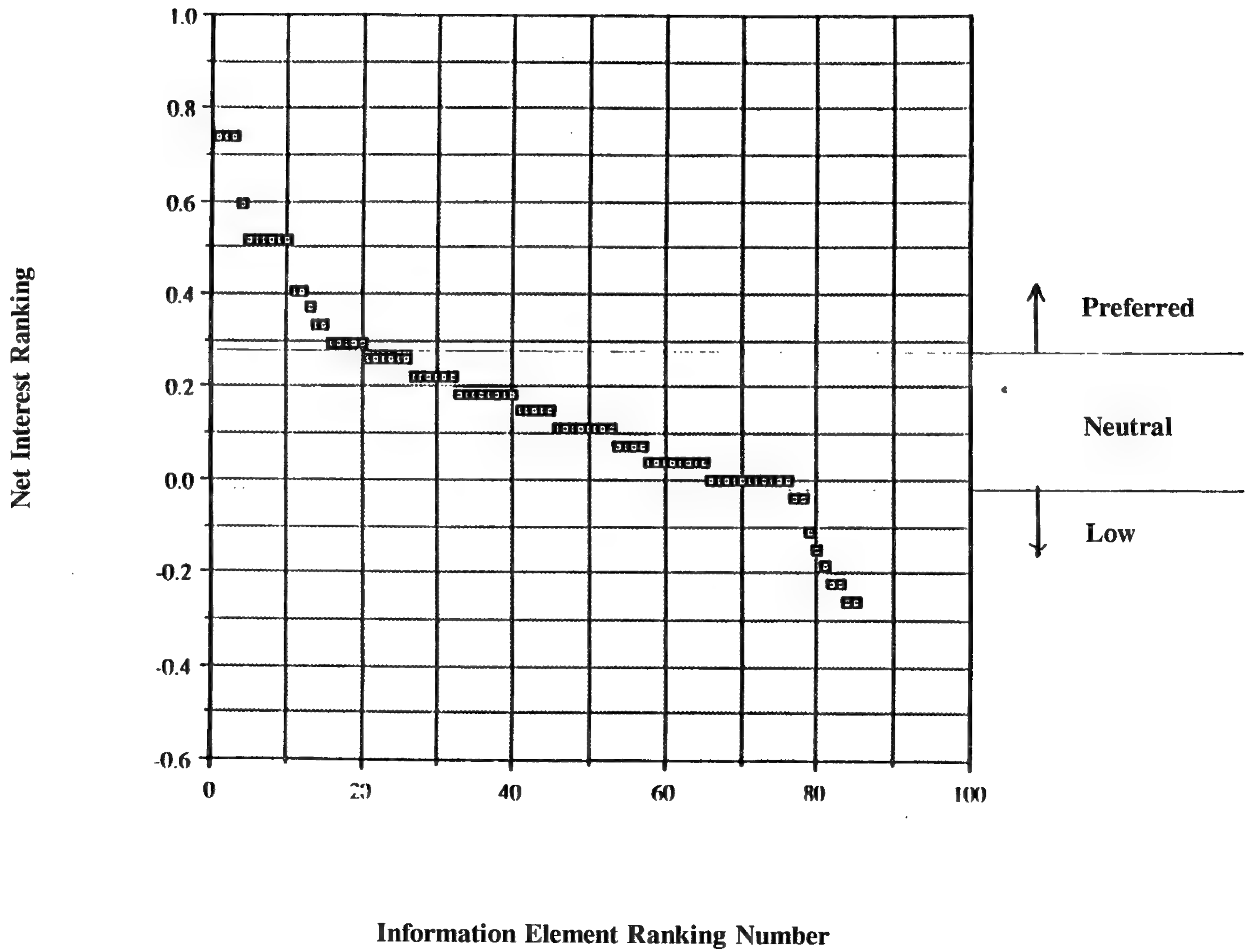
APPENDIX G

Net Interest Ranking Curves

Non-Precision Approach

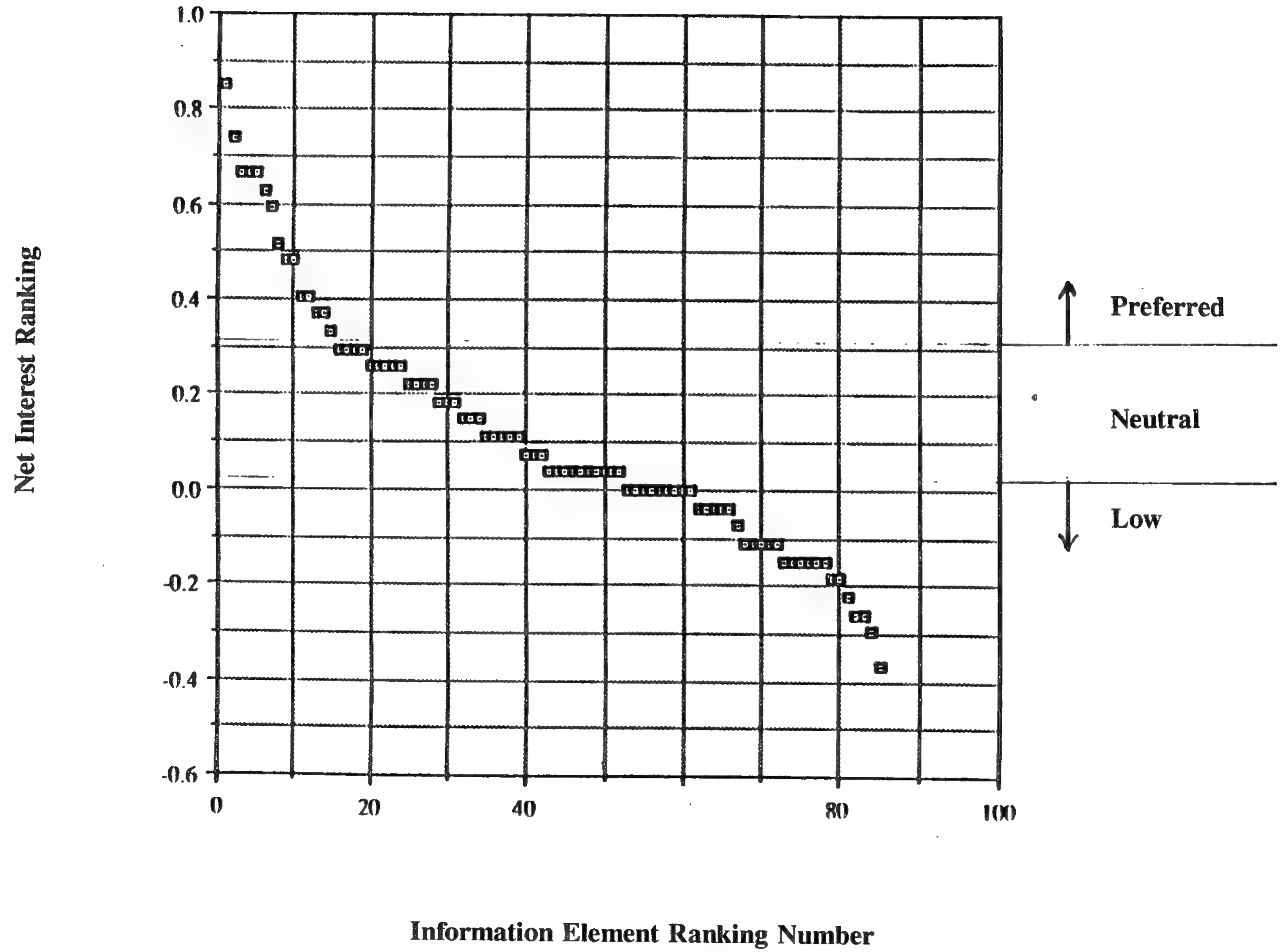
Non-Precision Approach

Pre-Approach Phase of Flight



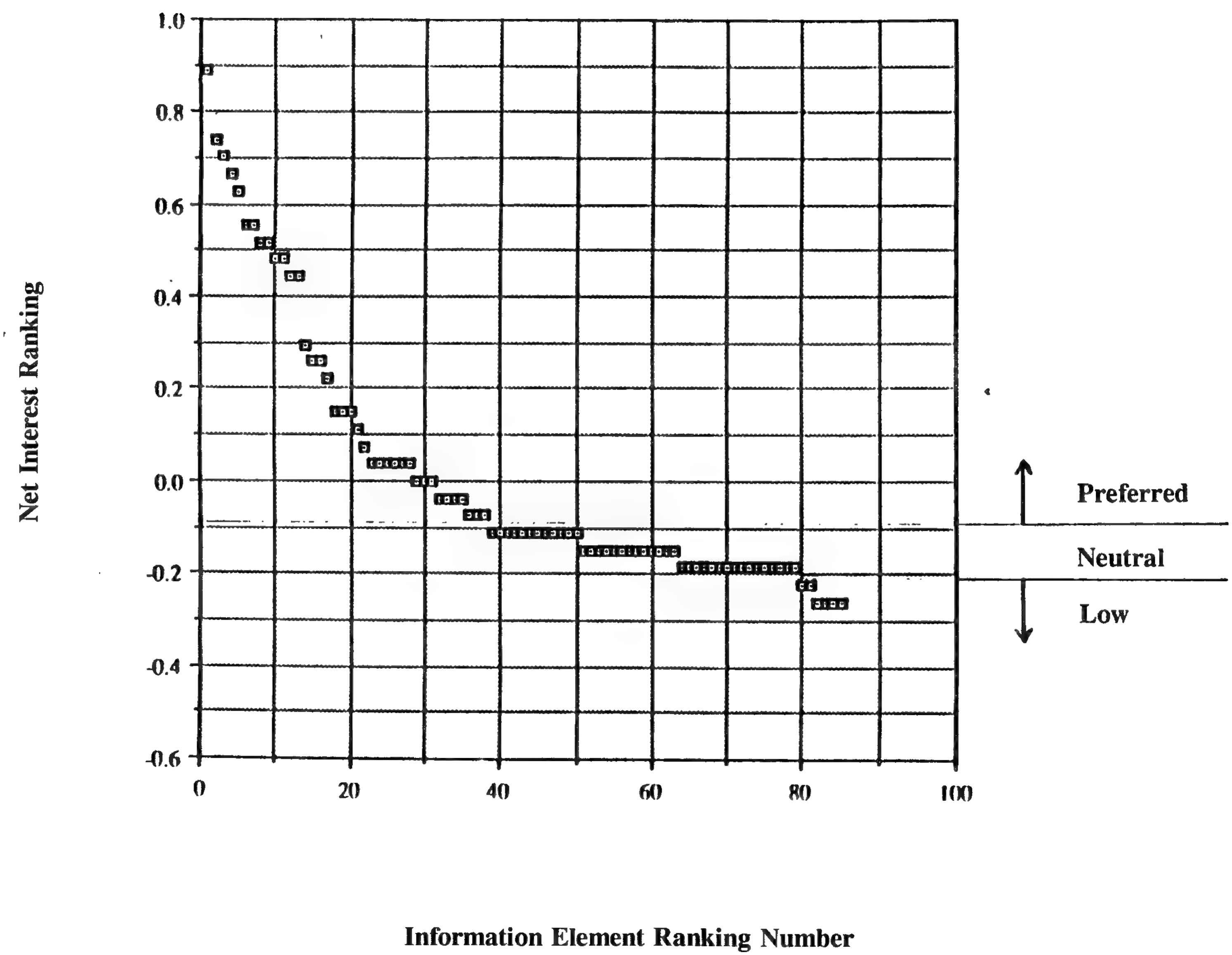
Non-Precision Approach

Approach Phase of Flight



Non-Precision Approach

Missed Approach Phase of Flight



APPENDIX H

Preferred Information Elements per Phase of Flight

Precision Approach

Precision Approach

Phase of Flight	Preferred Information Elements		
	Element Rank	Information Element Description	Element Number
Pre Approach	1	Approach	11
	2	ILS Course	20
	3	ILS DME Box	25
	4	Minimums (Category)	57
	5	RVR (Category)	61
	6	Airport	10
	7	City	9
	8	Missed Approach Instructions	56
	9	Kennedy VOR	31
	10	ATIS Arrival Frequency	3
	11	MSA Altitude Depiction	7
	12	Airport Elevation	13
	13	Localizer Frequency	12
	14	La Guardia VOR Frequency	17 A
	15	Glide Slope Intercept Altitude (MSL)	38 A
	16	ATIS Arrival Frequency (NE)	3 B
	17	ATIS Arrival Frequency (SW)	3 C
	18	Tower Frequency	5
	19	Ground Speed (Category)	63
	20	Timing (Category)	67
Approach	1	Minimums (Category)	57
	2	ILS DME Box	25
	3	Missed Approach Instructions	56
	4	ILS Course	20
	5	Glide Intercept Altitude (MSL)	44 A
	6	RVR (Category)	61
	7	Tower Frequency	5
	8	IAF Name	36
	9	Glide Slope Intercept Altitude (MSL)	39
	10	Final Approach Course	41
	11	FAF Name	42
	12	Approach	11
	13	Localizer Frequency	12
	14	Missed Approach Heading	29
	15	Missed Approach Fix	32
	16	ILS DME	37
	17	FAF DME	43
	18	FAF Intercept Altitude (MSL)	45
	19	TDZE	54
	20	Glide Intercept Altitude (AGL)	44 B
	21	Kennedy VOR	31
	22	DME	48
	23	Glide Slope Intercept Altitude (MSL)	38 A
	24	TDZE DME	52
	25	Glide Slope Intercept Altitude (AGL)	38 B
	26	Airport Elevation	13
	27	Airfield Diagram	30

Precision Approach

Phase of Flight	Preferred Information Elements		
	Element Rank	Information Element Description	Element Number
Missed Approach	1	Missed Approach Instructions	56
	2	Missed Approach Heading	29
	3	Missed Approach Fix	32
	4	Approach Frequency	4
	5	MSA Altitude Depiction	7
	6	Airfield Diagram	30
	7	Kennedy VOR	31
	8	Tower Frequency	5
	9	Airport	10
	10	Ground Frequency	6
	11	City	9
	12	Approach	11
	13	Airport Elevation	55
	14	Localizer Frequency	12
	15	Approach Plate Date	1
	16	Approach Plate Page	2
	17	ATIS Arrival Frequency	3
	18	MSA Identifier	8
	19	ATIS Arrival Frequency (NE)	3 B
	20	ATIS Arrival Frequency (SW)	3 C
	21	Airport Elevation	13
	22	FAF Name	23
	23	FAF DME	24
	24	ILS DME Box	25
	25	DME	48
Ground Operations	1	Ground Frequency	6
	2	Tower Frequency	5
	3	ATIS Arrival Frequency	3
	4	Approach Frequency	4
	5	ATIS Arrival Frequency (NE)	3 B
	6	ATIS Arrival Frequency (SW)	3 C
	7	Approach Plate Date	1
	8	Approach Plate Page	2

APPENDIX I

Preferred Information Elements per Phase of Flight

Non-Precision Approach

Non-Precision Approach

Phase of Flight	Preferred Information Elements		
	Element Rank	Information Element Description	Element Number
Pre Approach	1	Approach Identification	12
	2	LOM Frequency	34
	3	Minimums	71
	4	RVR (Catergory)	74
	5	FAF Intercept Altitude (MSL)	63
	6	City	10
	7	Airport	11
	8	FAC Heading (LOM Inbound)	31
	9	Final Approach Course (Inbound to LOM)	37
	10	Intercept Altitude (MSL)	59
	11	ATIS Arrival Frequency	3
	12	Timing (Category)	78
	13	NDB Frequency	13
	14	Cross Radial Heading (265)	40
	15	Missed Approach Instructions	70
	16	Tower Frequency	5
	17	Airport Elevation	14
	18	Cross Radial DME to Fix (Grity Int)	41
	19	Cross Radial Heading (347)	42
	20	Ground Speed (Category)	76
Approach	1	LOM Frequency	34
	2	FAF Intercept Altitude (MSL)	63
	3	Final Approach Course (Inbound to LOM)	37
	4	FAC Heading (LOM Inbound)	31
	5	Intercept Altitude (MSL)	59
	6	Final Approach Course Inbound (039)	67
	7	Final Approach Course	62
	8	Minimums	71
	9	LOM (Depiction)	66
	10	Timing (Category)	78
	11	Tower Frequency	5
	12	Ground Speed (Category)	76
	13	Cross Radial Heading (121)	25
	14	FAF Intercept Altitude (AGL)	64
	15	Airfield Diagram	30

Non-Precision Approach

Phase of Flight	Preferred Information Elements		
	Element Rank	Information Element Description	Element Number
Missed Approach	1	Missed Approach Instructions	70
	2	STW Frequency	24
	3	Cross Radial Heading (121)	25
	4	MORNS Intersection	21
	5	Map Holding Fix (061,241)	28
	6	Cross Radial Heading (155)	18
	7	Cross Radial Identifier (STW)	23
	8	SAX Frequency	19
	9	Missed Approach Course	29 A
	10	Cross Radial Identifier (SAX)	17
	11	Cross Radial Identifier (SBJ)	26
	12	DME to Fix (MORNS Intersection)	20
	13	SBJ Frequency	27
	14	Airfield Diagram	30
	15	Approach Frequency	4
	16	MSA Altitude Depiction	8
	17	Approach Identification	12
	18	Tower Frequency	5
	19	City	10
	20	NDB Frequency	13
	21	Airport	11
	22	ATIS Arrival Frequency	3
	23	Approach Plate Date	1
	24	Approach Plate Page	2
	25	Ground Frequency	6
	26	MSA Identifier	9
	27	Airport Elevation	14
	28	Airport Elevation	69
	29	Helicopter and Sea Plane Frequency	7
	30	FAC Heading (LOM Inbound)	31
	31	Minimums	71
	32	Numerical Scaling	15
	33	Final Approach Course Obstacles	32
	34	Linden Airport	33
	35	LOM Frequency	34
	36	Teterboro Airport	29
	37	Grity	48
	38	Timing (Category)	78

APPENDIX J

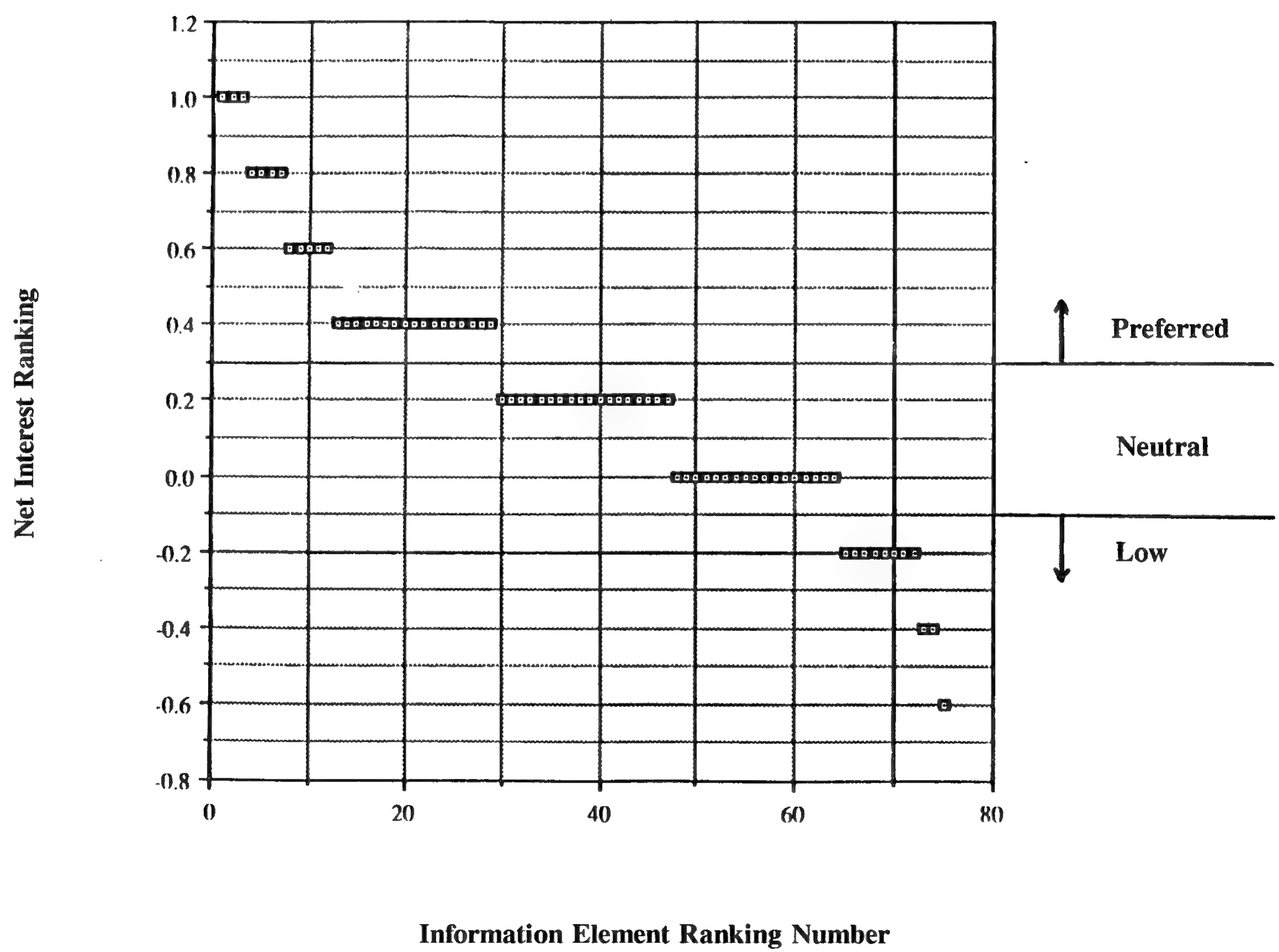
Net Interest Ranking Curves

"Glass-Cockpit" Subgroup

Precision Approach

Pre-Approach Phase of Flight

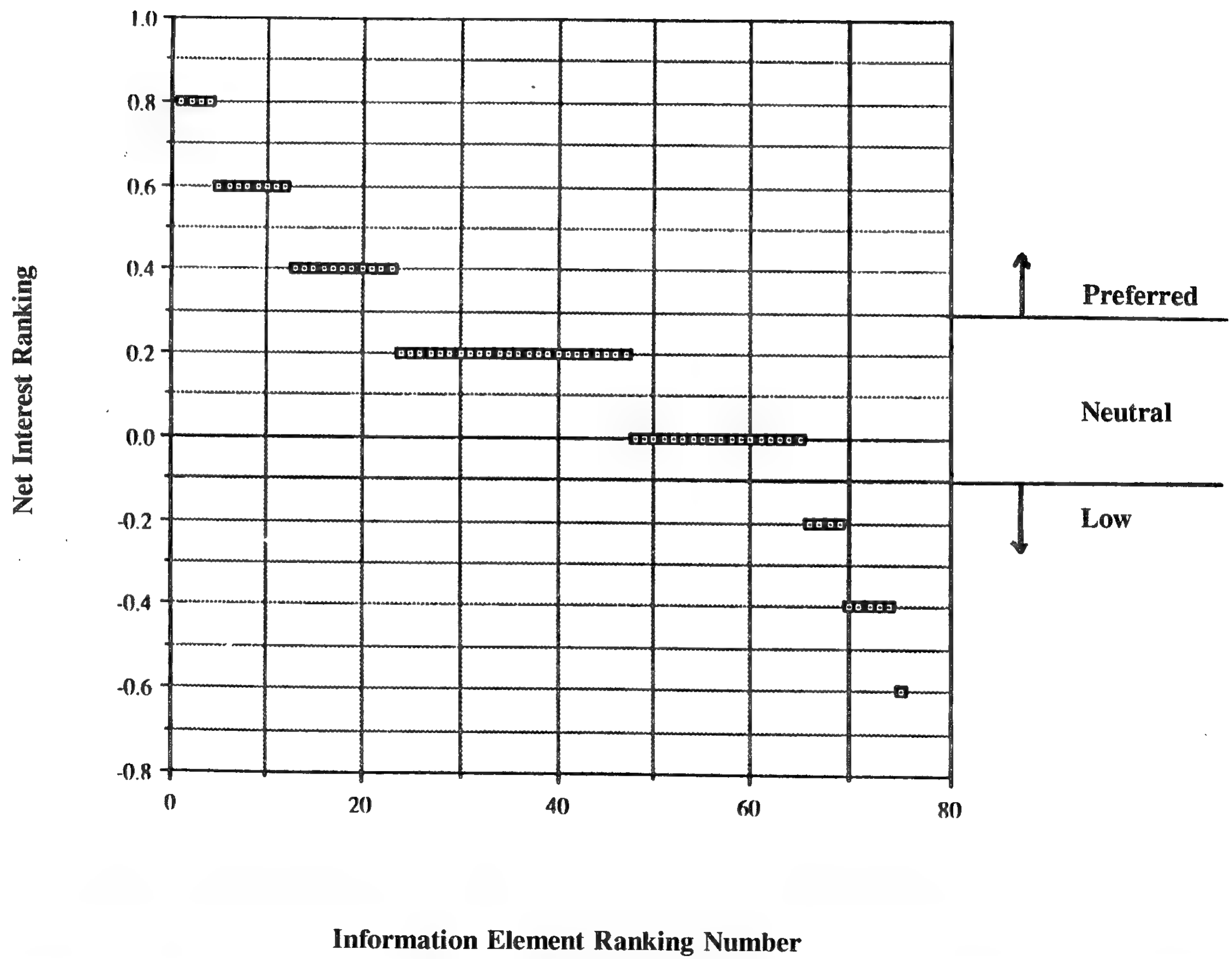
Subgroup



Precision Approach

Approach Phase of Flight

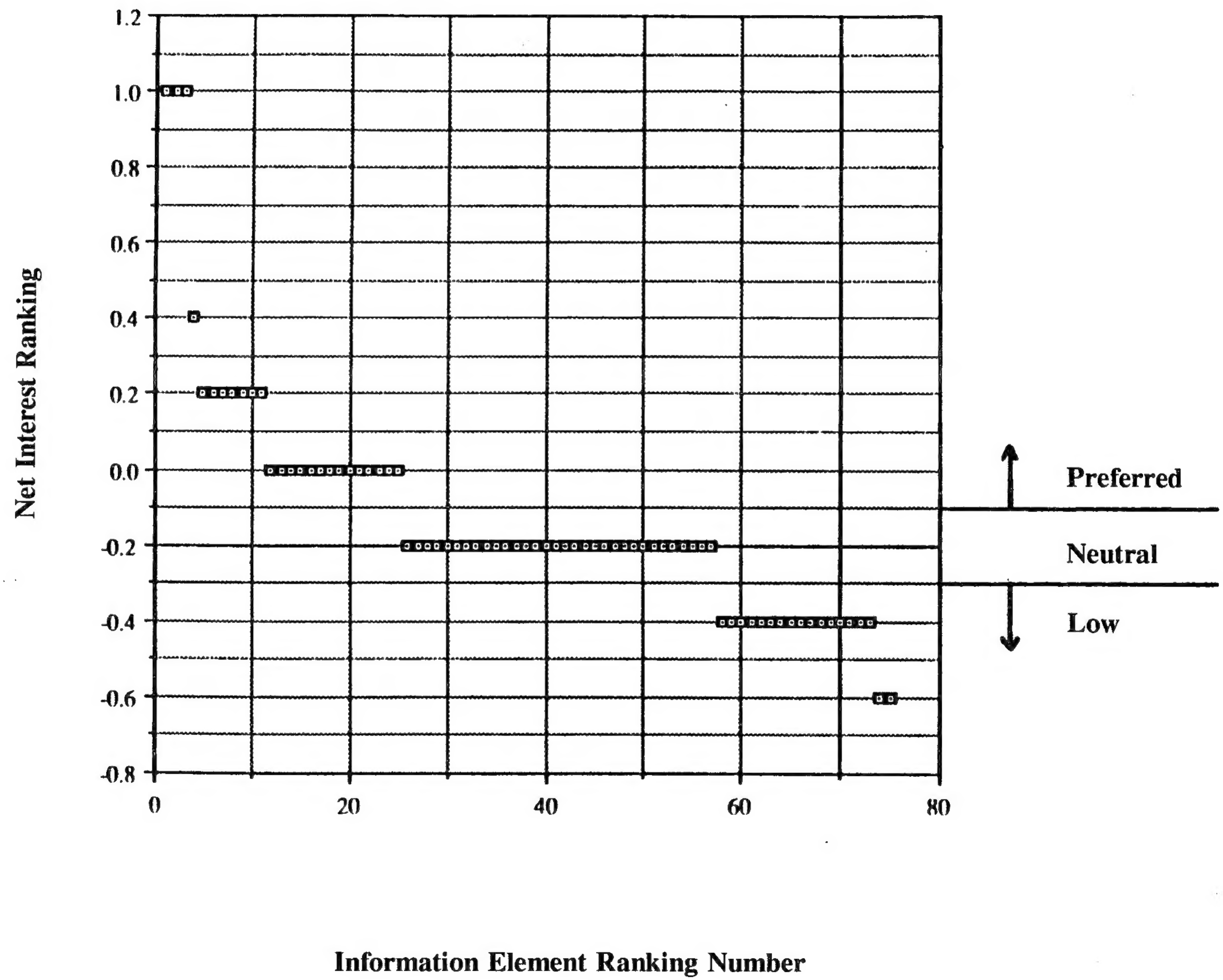
Subgroup



Precision Approach

Missed Approach Phase of Flight

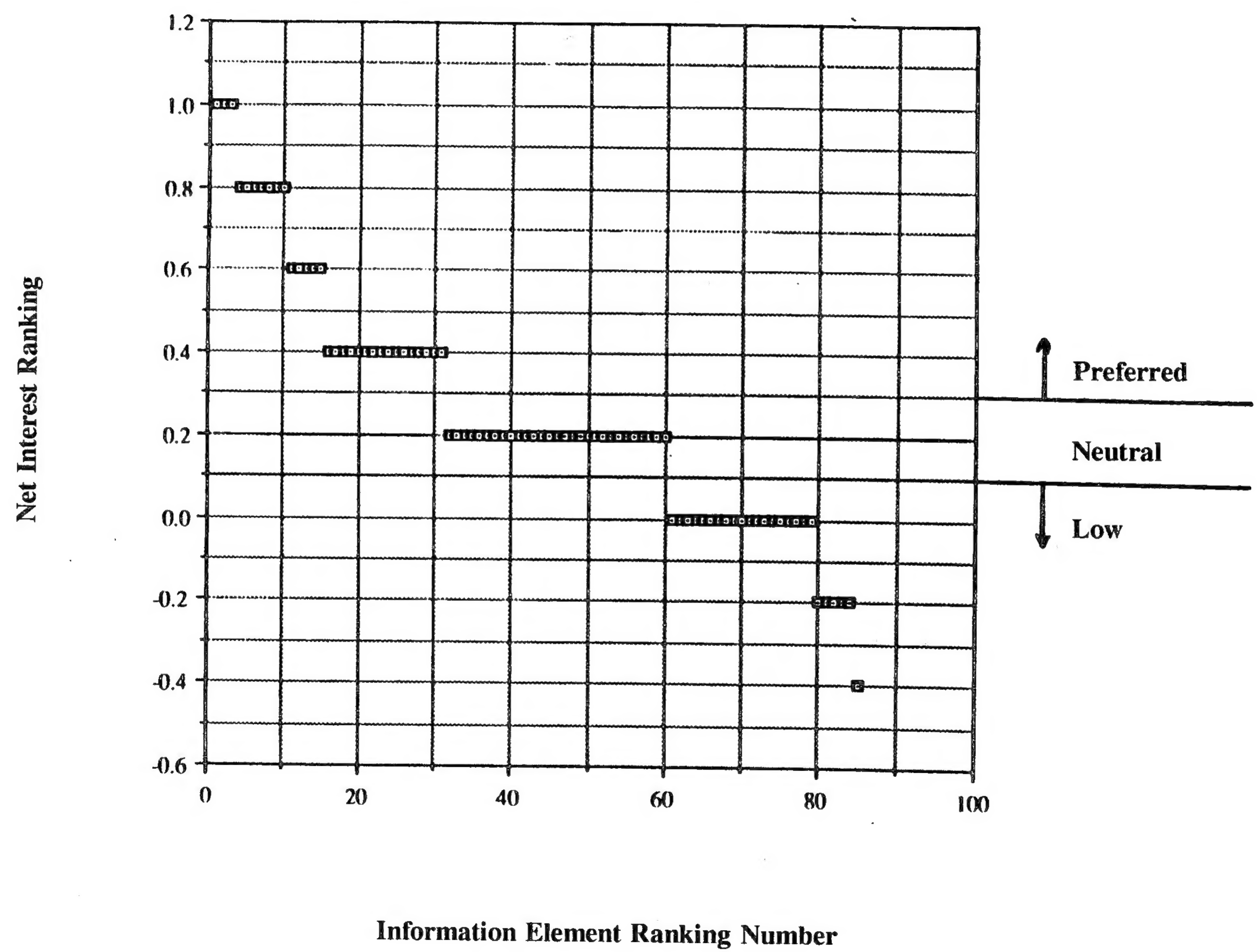
Subgroup



Non-Precision Approach

Pre-Approach Phase of Flight

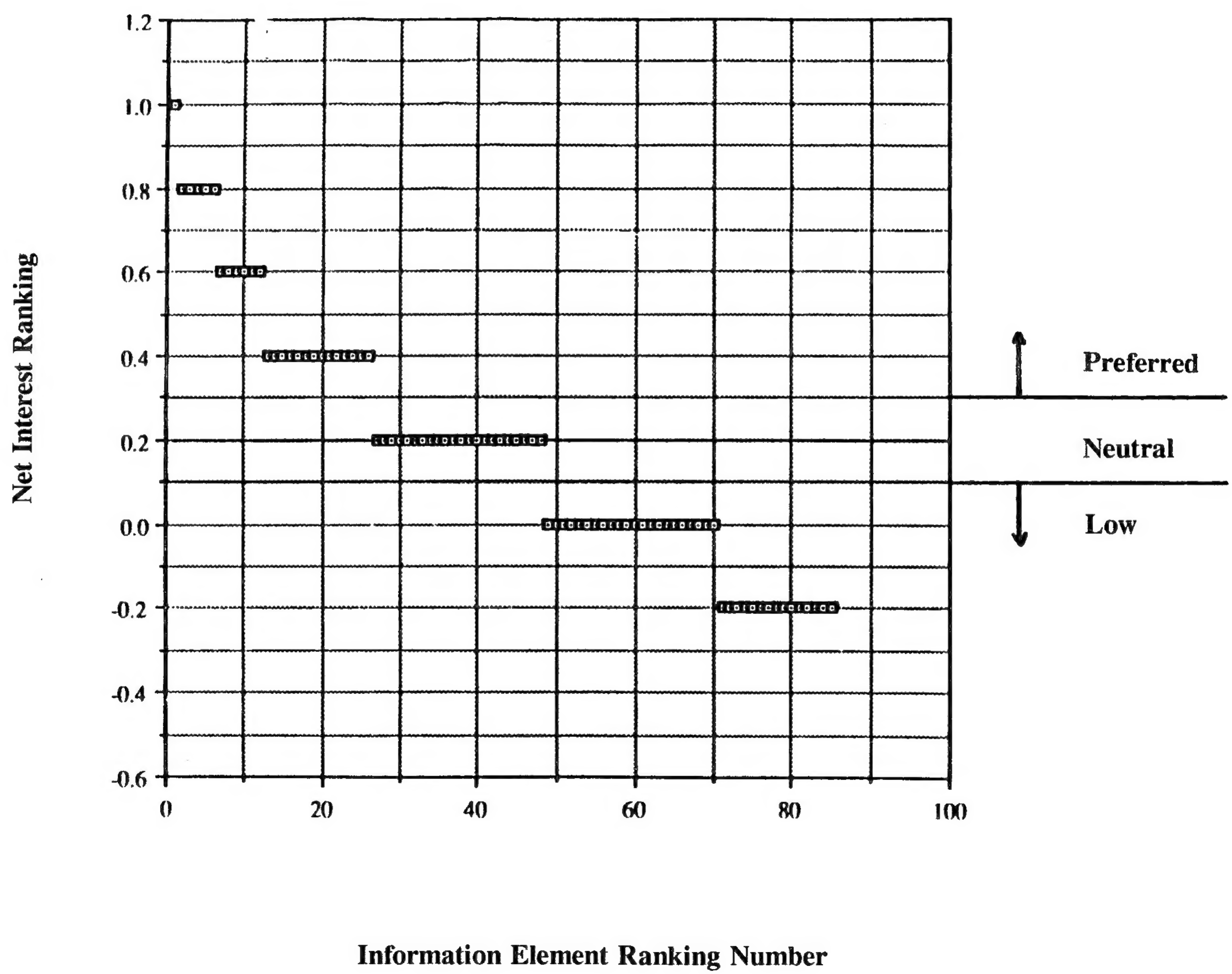
Subgroup



Non-Precision Approach

Approach Phase of Flight

Subgroup



Non-Precision Approach

Missed Approach Phase of Flight

Subgroup